

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES

**EVOLUTION OF NEVADA'S WATER LAWS,
AS RELATED TO THE
DEVELOPMENT AND EVALUATION
OF THE
STATE'S WATER RESOURCES,
FROM 1866 TO ABOUT 1960**

By
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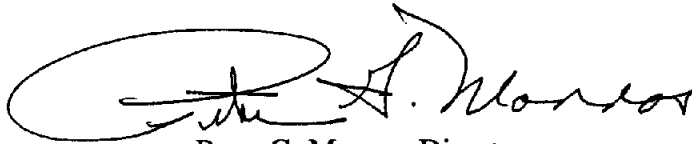
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FOREWORD

This fascinating narrative recounts the evolution of surface-water and ground-water law in Nevada, beginning in 1866 (2 years after statehood), and discusses the problems confronted by the Nevada State Engineers in connection with the development of the State's water resources since 1903, when that office was created. In addition, the report discusses water-related data-collection activities and studies by the U.S. Geological Survey in cooperation with the State Engineer through about 1960. The author, Hugh Shamberger, is uniquely qualified to write this history, having lived a large part of it. Hugh, who celebrated his ninetieth birthday on February 20, 1990, began his career with the State in 1931, was the State Engineer from 1951 to 1957, and was Director of the newly created Nevada Department of Conservation and Natural Resources from 1957 to his "retirement" in 1965. Subsequently, Hugh authored a widely acclaimed series of reports regarding the water problems faced by early mining camps of Nevada. The present treatise represents the culmination of Mr. Shamberger's historical research.

This document should prove to be of considerable interest, Statewide, as a historical resource. The report also may be of some interest regionally and nationally, because Nevada is the Nation's driest state.



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CONTENTS

	<i>Page</i>
ABSTRACT -----	1
INTRODUCTION -----	1
THE EARLY STRUGGLE TO ENACT WATER LAWS IN NEVADA -----	3
NEVADA'S SURFACE-WATER LAWS -----	4
The two doctrines--riparian and appropriation -----	4
Legislative foundations of surface-water law in Nevada -----	6
1866 -----	6
1869 -----	6
1879 -----	6
1887 -----	11
1889 -----	11
1891 -----	14
1893 -----	14
1899 -----	14
1901 -----	16
1903 -----	17
Irrigation Law of 1903 -----	17
Truckee-Carson Irrigation Project--The Newlands Project -----	19
First State Engineer -----	19
1905 -----	20
1907 -----	21
1909 -----	22
1911 -----	22
1913 -----	23
NEVADA'S GROUND-WATER LAWS -----	24
Legislative foundations -----	24
1879 -----	25
1887 -----	26
1901 -----	26
1905 -----	27
1913 -----	27
1915 -----	28
1935 -----	30
1937 -----	30
1939 -----	31
Discussion -----	31
Early recognition of underground water -----	32
Applications to appropriate underground water -----	33
DEVELOPMENT OF NEVADA'S WATER RESOURCES AS CHRONICLED IN THE STATE ENGINEERS' BIENNIAL REPORTS -----	34
1903-04 -----	34
1905-06 -----	36
1907-08 -----	37
1909-10 -----	38
Carey Act projects -----	39
Incidental duties--construction work -----	39
A suggested water law -----	39
State water right surveyors -----	40
Protested applications -----	40
Recommendations -----	40

	<i>Page</i>
DEVELOPMENT OF NEVADA'S WATER RESOURCES	
AS CHRONICLED IN THE STATE ENGINEERS'	
BIENNIAL REPORTS--Continued	
1911-12 -----	41
Irrigation investigations -----	41
Las Vegas underground water resources -----	41
1913-14 -----	42
1915-16 -----	43
1917-18 -----	43
1919-20 -----	44
Colorado River -----	44
Ground water -----	44
Stock-watering rights -----	45
Stream-measurement programs -----	45
Irrigation investigation -----	45
Cooperative snow surveys -----	45
1921-22 -----	45
State water right surveyors -----	46
Snow surveys -----	46
Colorado River Development Commission -----	46
Owyhee River Commission -----	47
1923-24 -----	47
1925-26 -----	48
Stock watering Act of 1925 -----	48
In retrospect for the years 1903-26 -----	49
Processing water-right applications -----	50
Adjudication of vested water rights -----	50
Distribution of water on adjudicated streams -----	50
Related and miscellaneous work -----	51
Carey Act -----	51
Cooperative stream measurement -----	51
Snow-survey work -----	51
Ground water -----	51
Other related work -----	51
An aside -----	51
1927-39 -----	52
Underground water -----	52
Historic runoff of Nevada streams -----	53
Biennial Reports, 1931-34 -----	53
The Years 1935-39 -----	54
Colorado River Commission -----	55
Nevada State Planning Board -----	55
Special reports -----	55
Testing for leakage in wells in Las Vegas Valley -----	55
Comprehensive Underground-Water Act -----	57
1940-43 -----	58
Ground-water use in the Las Vegas Valley -----	58
State Engineer designates Las Vegas and Pahrump Valleys -----	58
EVALUATION OF NEVADA'S WATER RESOURCES--THE	
U.S. GEOLOGICAL SURVEY COOPERATIVE PROGRAMS -----	
The stream-gaging program -----	59
1889-1908 -----	59
1913-46 -----	61
1946-49 -----	63
1956-62 -----	64
The Statewide ground-water program -----	67

	<i>Page</i>
CONCLUSION	74
APPENDIX 1: HUMBOLDT RIVER RESEARCH PROJECT	75
U.S. Geological Survey	76
Ground Water Branch	76
Surface Water Branch	77
Quality of Water Branch	77
General Hydrology Branch	77
Nevada Bureau of Mines, Desert Research Institute, University of Illinois, Department of Geology	77
U.S. Agricultural Research Service	78
U.S. Soil Conservation Service	78
Reports	79
APPENDIX 2: NEVADA LAND GRANTS	80
Railroad grant	82
Statistical data regarding ownership of land	83
Federal lands under jurisdiction of Federal agencies in Nevada, June 30, 1966	84
APPENDIX 3: THE CAREY ACT	85
Early Carey Act land applications	85
The Pacific Reclamation Project	85
Bishop Creek Dam	88
Branch railroad to Metropolis	88
The story of Metropolis	89
Unfortunate end of the Pacific Reclamation Company	90
OTHER EARLY FEDERAL LAND LEGISLATION	90
Homestead Act	90
Desert Land Act	90
APPENDIX 4: STATE ENGINEERS SINCE CREATION OF OFFICE	91
DIRECTORS, NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES, SINCE CREATION OF OFFICE	91
U.S. GEOLOGICAL SURVEY PERSONNEL IN CHARGE OF HYDROLOGIC COOPERATIVE PROGRAMS IN NEVADA	92
APPENDIX 5: SPECIAL ARTICLES OF INTEREST THAT APPEAR IN THE STATE ENGINEERS' BIENNIAL REPORTS	94
APPENDIX 6: WATER-SUPPLY PROBLEMS FACED BY EARLY MINING CAMPS OF NEVADA	99

ILLUSTRATIONS

	<i>Page</i>
Figure 1. Map of Nevada showing areas described in reports of the "Nevada Water-Resources Bulletin" series -----	71
2. Map of Nevada showing areas described in reports of the "Nevada Water-Resources Reconnaissance" series -----	73

TABLES

Table 1. Summary of major legislative acts affecting water resources of Nevada from Statehood to 1960 -----	7
2. The trend in the filing of applications as between surface water and ground water, 1905-55 -----	33
3. Reports of the "Nevada Water-Resources Bulletins" series -----	70
4. Reports of the "Nevada Water-Resources Reconnaissance" series -----	72

Evolution of Nevada's Water Laws, as Related to the Development and Evaluation of the State's Water Resources, From 1866 to About 1960

By Hugh A. Shamberger

ABSTRACT

This report describes the evolution of surface-water and ground-water law in Nevada, beginning in 1866 (2 years after statehood), and recounts the problems confronted by the Nevada State Engineers in connection with the development of Nevada's water resources from 1903, when that office was created. The programs of stream gaging and ground-water studies by the U.S. Geological Survey in cooperation with the Office of State Engineer are discussed from the State perspective. The Carey Act and its application to the reclamation of desert lands in Nevada also is described.

INTRODUCTION

The purpose of this treatise is to record the development of water laws for the State of Nevada which were enacted to adequately utilize and safeguard the water resources in the most arid State in the Nation. In addition, the major water-related activities of the Office of State Engineer during the first half of the 20th Century are described. The appraisal of the water resources of the State by the U.S. Geological Survey and other Federal agencies is presented in some detail. This, as well as other pertinent material set forth herein, is intended to provide the reader and researcher with the interesting history of the early development of the Nevada water law, starting in 1866, together with the problems that confronted the State Engineers, that otherwise would be difficult to obtain.

When the scope of this work was originally discussed with the U.S. Geological Survey, the time frame was to be limited to the development of Nevada water law from 1866 to 1939. After the author started his research on the numerous water laws passed by the legislature, it was evident that such laws were so interwoven with the general activities of the State Engineer that it was mutually agreed to broaden the scope of this dissertation to include, to a limited extent, the overall work done by the various State Engineers.

When the author entered the Office of State Engineer in 1935, copies of all the early biennial reports of the State Engineers were still available. These provided much of the early history of the water activities of the State Engineer. Now, many of these early biennial reports are no longer available.

Therefore, this compilation may be the only readily available source of information that summarizes the early workings of the State Engineers, together with a digest of the water laws, and should prove valuable to those who are interested in learning about the many problems confronted by State Engineers in their efforts to determine the extent and subsequent protection of the water resources of Nevada. Several appendices contain information that generally relates to the water resources of the State, and should add to the value of this treatise.

The data on the laws affecting water resources were generally taken from the Nevada Compiled Laws. The earliest legislation relating to water was enacted in 1866--2 years after statehood--and provided a method for appropriators of water from any river or stream to make a record of such diversion ditches or flumes with the proper county recorder. This act (Chapter 100, Statutes of 1866), together with amendments in 1869 and 1889, provided the only method by which an appropriator could record his right to divert water through ditches and obtain a right-of-way, until 1903, when the Legislature created the Office of State Engineer, and thus provided means to adjudicate existing rights.

State Engineer Frank R. Nicholas made the following comment in his 1907-08 Biennial Report:

"The passage of the Irrigation Laws of 1903, by which the office of State Engineer was created, was due to the existing conditions governing the appropriation and distribution of water rights in the State of Nevada. There had grown up in this State prior to 1903 a mass of water rights which were inchoate and undetermined, arising from what might be termed an extension of 'squatter sovereignty,' whereby appropriators simply avail themselves of the use of public waters by appropriating them and constructing ditches for their diversion, often failing to record the required notices in the county in which the appropriation was made and to make public in any way their intentions, save by the actual fact of construction."

The laws pertaining to underground water in Nevada and the western states have developed much more slowly than those pertaining to surface water. A number of reasons account for this, of which a few of the more obvious are herewith mentioned: (1) The lack of knowledge of the physical conditions under the surface of the earth where ground water occurs. The difficulty of ascertaining the existence, the extent, and the movements of an underground water supply made difficult the task of courts and lawmakers in formulating rules for the conservation and wise use of such waters. (2) It is quite natural in an arid region that available surface water should first be utilized. Because it was visible, surface water could readily be located, the supply could be easily ascertained, and its general physical characteristics were capable of quicker and easier determination. The early use of surface water naturally required the development of the laws applicable to such waters. (3) The expense entailed in the digging or sinking of wells or the pumping of water has been an important factor in retarding its early use for irrigation. Consequently, as the use of surface waters led to the development of the laws applicable to such waters, so the lag in the general use of ground waters retarded the growth of ground-water laws.

The Nevada statutes from statehood in 1864 to 1903 contain only three acts relating to underground water, whereas 20 statutes relating to surface water were enacted during this same time period. These three statutes were enacted in 1879, 1887, and 1901 and provided bounties for the development of artesian water. The early legislatures seemed to construe artesian water as water under free flow. In other words, a well would have to be a flowing well to be classified as an artesian well.

The State of Nevada first took cognizance of underground water as belonging to the public and subject to appropriation when it enacted a new water law in 1913. Sections 1 and 2 of Chapter 140, Statutes of 1913, read as follows:

SECTION 1. The water of all sources of water supply within the boundaries of the state, whether above or beneath the surface of the ground, belongs to the public.

SECTION 2. Subject to existing rights, all such water may be appropriated for beneficial use as provided in this act and not otherwise.

The first legislative act relating to the administration of underground water was contained in Chapter 210, Statutes of 1915, and remained in force until repealed by the more detailed ground-water law of 1939 (Chapter 178, Statutes of 1939). Section 1 of the 1915 act read:

All underground waters, save and except percolating water, the course and boundaries of which are incapable of determination, are hereby declared to be subject to appropriation under the laws of the state relating to the appropriation and use of water. [Emphasis added.]

The balance of the act related to the drilling and control of artesian waters. The 1939 ground-water act eliminated the reference to percolating water and made all ground water, capable of being developed, subject to the appropriation laws of the State. This concept is further discussed under the section on ground-water laws.

THE EARLY STRUGGLE TO ENACT WATER LAWS IN NEVADA

The history pertaining to the evolution of the water law in Nevada is an interesting one. Prior to 1903, the information available is contained in the legislative history of that period. Following 1903, the biennial reports of the State Engineers were the principal source of information. The first such report was submitted on December 31, 1904, by A.E. Chandler, who was appointed the first State Engineer of Nevada by Governor John Sparks. (A listing of the State Engineers and their periods of tenure is presented in appendix 4.) The author refers to these reports throughout this treatise, as they detail the activities of the State Engineer and in most instances are the main source of information relating to the use and control of the water resources of the State.

For several years after the organization of the Territory of Nevada in 1861, there were no statutory laws concerning water rights.¹ Not until about 2 years after Nevada became a state (October 31, 1864) was there any legislation pertaining to its water resources.

From the time of statehood until the mid 1880's, the non-aboriginal population of the State was concentrated in towns developed as a result of the discovery of rich deposits of gold, lead, and silver. Towns, such as Virginia City, Austin, Eureka, Candelaria, Silver Peak, Pioche, and Tuscarora, all reached their peak populations prior to 1880. The non-aboriginal population of Nevada in 1870 was 42,500; in 1880 it was 62,300, but in 1890 the population had declined to 47,400.² This decrease in non-aboriginal population was, no doubt, due to the decline of mining activities during the latter part of the 19th century.

Irrigation first started in Nevada during the late 1840's and early 1850's. No doubt the settlers first used the water from the perennial streams flowing from the eastern slope of the Sierra Nevada, followed closely by water diversions from the Carson, Walker, Truckee, Humboldt, and Muddy Rivers. It would seem likely that irrigation first started in Carson, Washoe, Eagle, and Muddy River valleys.

¹ The Organic Act, creating the Territory of Nevada, was signed by President James Buchanan on March 2, 1861.

² From the U.S. Census Bureau records.

Prior to the passage of the 1905 amendments to the 1903 Irrigation Law, little legislation was enacted pertaining to water for mining and milling operations (appendix 6). With regard to water for irrigation, no need existed for legislation as there was no conflict at that time among water users.

NEVADA'S SURFACE-WATER LAWS

The western law of water rights embraced the common law doctrine of riparian rights and the statutory doctrine of prior appropriation. The principles underlying these two doctrines are diametrically opposed to each other: the former being based on the ownership of land contiguous to a stream, without regard to the time of use or to any actual use at all, and the latter on the time of use and on actual use without regard to the ownership of land contiguous to a water course.

The Two Doctrines--Riparian and Appropriation

The doctrine of riparian rights to the use of water has been completely abrogated in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. The Pacific Coast states (Washington, Oregon, and California) and the tier of six states, starting with North Dakota on the north and extending southward to Texas, recognize to varying degrees both the appropriation and the riparian doctrines. The effect of court decisions as statutes have made the existence of the riparian doctrine of minor significance in Oregon, Washington, and Kansas.

The appropriations doctrine is recognized on surface waters in all states west of the 100th Meridian. As previously mentioned, however, only eight of the western states are exclusively appropriation states.

The riparian doctrine as it applied to water courses, related only to land through which the stream or river ran and extending back from the water course to the limits of the land owner's original property right. In other words, land susceptible to irrigation lying away from the riparian land and in other ownership could claim no riparian water rights and would, therefore, have to appropriate the water for use on such lands under the rules and provisions of the respective states. This brought about the early necessity for the western states to provide legislation permitting a land owner to appropriate water under state law.

In the western states where the land along and contiguous to a stream had not passed from government ownership into private ownership, no riparian rights prevailed and the appropriation doctrine would apply, but would be subject to other upper or lower riparian rights. This brought about many legal battles.

Under the appropriation doctrine, the first user of water from a water course acquired a priority right to the use and to the extent of his use, but contiguity of land to the stream or river was not a factor.

A further brief resumé of the two doctrines, which have had a profound effect on the evolution and growth of western water law, is herewith given: The right to the use of water under the riparian doctrine rises by operation of law as an incident to the ownership of riparian land, of which the right is part and parcel. Acquisition of the land automatically resulted in acquisition of water right. Only land contiguous to or abutting upon a natural stream and lake would be riparian land. The doctrine, in states where it has been recognized, has been generally modified to allow each appropriator to make such use of the water for irrigation of his riparian land as is reasonable in relation to the similar requirements of other owners of lands riparian to the same stream. The right does not depend upon the use of the water and, therefore, nonuse does not result in its loss. This doctrine has not been recognized in Nevada since 1885.¹

In the arid part of the western states, the quantity of water available was usually far short of the quantity that would be required for the farming of all agricultural lands. As water was much less abundant in the west than good land, the problem was to distribute these water supplies where they could be most beneficially and economically used. Under the riparian doctrine, lands contiguous to watercourses have the prior claim to the waters of the stream solely by reason of location and regardless of the relative production capability of riparian land. The riparian doctrine was thus unsuited to the conditions of most western states.

The appropriation principle, in the form in which it is recognized throughout the west, sprang from the requirements of a mining region for protection in the use of water supplies needed to work mining claims. The placer gold mines of California developed a rule with respect to a possessory right to mining claims, giving the first appropriator of water, for the purpose of working a mining claim, a right to its superior use against all late comers. In other words, the first in point of time to put the water to a beneficial use, without limitation of the place of use to riparian land, came to be recognized through the sanction of court decisions.

Nevada early adopted the appropriation doctrine because its supply of water, even with the highest beneficial use, was often insufficient to supply its needs, but such adoption did not occur until after an earlier court decision had given recognition to the doctrine of riparian ownership.² However, as early as 1885, the Nevada Supreme Court approved the appropriation theory and has on subsequent occasions emphasized its rejection of the riparian doctrine. In other words, since 1885 our courts have ruled and our legislature has declared that there can be no ownership in the corpus of the water within the State of Nevada, but that the right to the use of water may only be acquired and that beneficial use shall be the basis and the measure of such right.

Under the Nevada water law there are two classes of water rights by appropriation: first, the so-called vested rights, initiated during the early days of the State's development and before any very definite laws concerning appropriation of water existed and, second, appropriation rights under which water was appropriated and beneficially used by virtue of permits granted by the State Engineer subsequent to March 1, 1905, when the legislature provided a statute allowing an appropriator to file with the State Engineer for a permit to appropriate water upon due application made to his office.

¹ Jones v. Adams, 19 Nev. 78, 6 Pac. 442 (1885).

² Barnes v. Sabron, 10 Nev. 217, 232 (1875).

Thus, two classes of water rights were created in Nevada: vested rights and permitted rights. Water rights created prior to March 1, 1905, are classed as vested rights, the magnitude and extent of which can be determined by a process of adjudication by the State Engineer under the water laws of the State, whereas rights initiated subsequent to March 1, 1905, are clear-cut and well defined as to magnitude and extent, having been granted upon direct application to the State Engineer.

Legislative Foundations of Surface-Water Law in Nevada

Major legislation that affected the early development of Nevada's surface-water resources is described below and summarized in table 1.

1866

Chapter 100

This act, approved March 3, 1866, was the first attempt of the Nevada State Legislature to obtain a record of water diversions. Section 1 provided that any person desiring to construct a ditch or flume was required to make an affidavit setting forth the name by which the ditch would be known and the description of the places of use. Such certificate was to be accompanied by a plat of the proposed ditch and filed with the county recorder of the county or counties through which the proposed ditch would be located. It was provided that the works of constructing the ditch would have to be commenced within 30 days of the time of making the certificate.

Provisions were made in Section 2 for the person proposing to construct the ditch to have the right of entry through property of others, and when such needed land couldn't be obtained by the consent of the owner, steps were provided for the appointment of appraisers.

Section 3 was intended to safeguard existing water rights.

Section 4 made the provision of the act to safeguard the rights of others who had theretofore constructed diversion ditches. However, the owners of such diversions were required to comply with the provisions of Section 1 in filing a certificate or plat with the appropriate county recorder.

1869

Chapter 77

Chapter 77 of the 1869 Statutes made a slight amendment to Section 2 of the 1866 act, mentioned above, relative to the appraisal of land owned by others and needed for a diversion ditch.

1879

Chapter 120

This act provides that the attorney general and Board of County Commissioners of Washoe County are authorized to commence suits or take such action as may be necessary to maintain a regular or natural flow of the water of the Truckee River.

TABLE 1.-- *Summary of major legislative acts affecting the water resources of Nevada from Statehood to 1960*

Statute	Chapter	Applied to		Legal status	Purpose (see text for more detail)
		Surface water	Ground water		
1866	100	x		Valid	To allow persons to divert water--to provide for right-of-way.
1869	77	x		Valid	Amends act of 1866.
1879	82		x	Ch. 383, Stat. 1957	Provides a bounty for developing artesian wells.
1879	120	x		Valid	Provides for the control of Truckee River.
1887	80	x		Valid	Right-of-way for waste water over lands of others.
1887	127		x	Ch. 383, Stat. 1957	Provides bounty for artesian wells.
1889	15	x		Not determined	Prohibits throwing sawdust, etc., in rivers.
1889	48	x		Valid	Prohibits unlawful waste of water.
1889	78	x		Not determined	To prevent water to run on public roads.
1889	104	x		Valid	Amends act of 1866.
1889	112	x		Repealed by Ch. 62, Stat. 1891	To provide for storage of water to encourage milling and mining and to reclaim land.
1889	113	x		Repealed by Ch. 127, Stat. 1893	To regulate use of water; setting priorities of rights and for condemnation of land for reservoirs.
1891	92	x		Repealed	Provides for organization of irrigation districts.
1893	64	x		Not determined	County commissioners of certain counties to change channels and courses of rivers to prevent damage to taxable property.
1899	49	x		Valid	Stored water may be turned into natural streams and reclaimed.
1899	61	x		Not determined	Washoe County empowered to purchase reservoir sites.
1899	97	x		Ch. 4, Stat. 1903	Permissive legislation to preserve existing water rights--storage of water and recording claims.

TABLE 1.-- *Summary of major legislative acts affecting the water resources of Nevada from Statehood to 1960--Continued*

Statute	Chapter	Applied to		Legal status	Purpose (see text for more detail)
		Surface water	Ground water		
1901	59	x		Ch. 117, Stat. 1945	Creates State Board of Irrigation to provide for measurement of streams in cooperation with U.S. Geological Survey and U.S. Department of Agriculture.
1901	76		x	Ch. 145, Stat. 1921	Bounty for developing oil, gas, or artesian water wells.
1903	4	x		Repealed by Ch. 18, Stat. 1907	Creates Office of State Engineer. Provides means to adjudicate water rights; known as Nevada Irrigation Law.
1903	47	x		Not determined	To determine losses of water used for irrigation in cooperation with U.S. Department of Agriculture and Nevada Agricultural Experiment Station.
1903	122	x		Ch. 221, Stat. 1917	To prevent pollution of water.
1905	46	x		Repealed by Ch. 18, Stat. 1907	Amends 1903 act, adding new sections providing for acquiring new water rights.
1905	151		x	Limited to 1905-06	Provides for sinking water wells in southern Nevada as an aid to miners.
1907	18	x		Ch. 140, Stat. 1913	Repealed the 1903 and 1905 irrigation laws-- provides a new water law. The State Engineer made a member of Board of Irrigation.
1907	57	x		Ch. 221, Stat. 1917	Amends Pollution Act of 1903.
1907	199	x		Limited to 1907-08	Provides for cooperative stream measurement with U.S. Department of Agriculture and Nevada Agricultural Experiment Station for 1907-08.
1909	31	x		Ch. 140, Stat. 1913	Amends Irrigation Law of 1907 and sets fee schedule.
1909	45	x		Not determined	State Engineer to safeguard appliances used for water regulation.
1909	81	x		Not determined	Mandates installation of headgates and weirs by users and diverters of public waters with permits.

TABLE 1.-- *Summary of major legislative acts affecting the water resources of Nevada from Statehood to 1960--Continued*

Statute	Chapter	Applied to		Legal status	Purpose (see text for more detail)
		Surface water	Ground water		
1909	164		x	Ch. 74, 76, Stat. 1911	Applies to operation of Carey Act.
1911	74	x	x	Valid	Creates Commission of Industry, Agriculture, and Irrigation. Provides for study of reclamation of land by use of underground water under provisions of Carey Act.
1911	76	x	x	Not determined	Provides duties of State Commission of Industry, Agriculture, and Irrigation in relation to the Carey Act. Legislation in 1915 placed all office matters of Commission in hands of State Engineer.
1911	141	x		Limited to 1911-12	Cooperative program among U.S. Department of Agriculture, Nevada Agricultural Experiment Station, and State Engineer to determine losses and their remedies from irrigation ditches, 1911-12.
1913	13		x	Ch. 383, Stat. 1957	Allowed counties to acquire land and drill for artesian water. Each county to spend no more than \$5,000 per year.
1913	54		x	Ch. 38, Stat. 1939	A law to provide for the conservation of underground water and for the casing and capping of flowing wells.
1913	140	x	x	Valid	Provides a new general water law that is the basis of the present law. Includes both surface and ground water as belonging to the State and subject to appropriation. Repeals the 1907 water law and 1909 amendments.
1913	174	x		Valid	Applies to permits to appropriate water when point of diversion or place of use are outside the State.
1913	181	x		Valid	To provide for investigation of water resources under a cooperative program between the U.S. Geological Survey and State Engineer. This program continues to date.
1915	97		x	Ch. 64, Stat. 1917	To establish at the University of Nevada, a public service department of engineering experimentation to aid settlers in the development of underground waters.

TABLE 1.-- *Summary of major legislative acts affecting the water resources of Nevada from Statehood to 1960--Continued*

Statute	Chapter	Applied to		Legal status	Purpose (see text for more detail)
		Surface water	Ground water		
1915	111		x	Ch. 383, Stat. 1957	Under this act the State assumes some of the cost for well drilling. This act amends the Act of 1913, Ch. 13, regarding the drilling for artesian water by counties.
1915	210		x	Ch. 178, Stat. 1939	This act excepts "percolating water, the course and boundaries of which are incapable of determination" from the provisions of Ch. 146, Stat. 1913.
1925	201	x	x	Inactive	Stock Watering Act of 1925. Not active since advent of the U.S. Bureau of Land Management.
1935	184		x	Ch. 178, Stat. 1939	Amends the 1915, Ch. 210, act to prevent loss of water above and below ground surface. For first time State Engineer is empowered to administer provisions of underground water control.
1937	149		x	Ch. 178, Stat. 1939	Amends Ch. 210, Stat. 1915, and Ch. 184, Stat. 1935. Requires permits to appropriate ground water in proven artesian basins prior to drilling. State Engineer to make reasonable rules.
1939	178		x	Valid	Nevada's Underground Water Act, which, with many subsequent amendments, governs the control of the State's underground water resources by the State Engineer. This act places all underground water under State control.
1945	117		x	Valid	Enabling act authorizing State Engineer to enter into cooperative programs with the U.S. Geological Survey to make statewide ground-water studies.
1951	110	x		Valid	Unlawful to place any obstruction that shall interfere with the use of water by an appropriator to use his diversion works.
1960	181		x	Valid	Provides for a cooperative program with the U.S. Geological Survey to make reconnaissance ground-water studies.

1887

Chapter 80

This act provides that any person or persons who have constructed or may construct any ditch for the purpose of diverting water from any river or stream would have the right to enter upon private lands for the purpose of constructing waste ditches for surplus water. If the owner of such private lands would not consent to the right-of-way needed for the waste ditch or ditches their recourse could be taken to the provisions in the 1866 and 1869 acts previously mentioned.

1889

The year 1889 saw the Nevada State Legislature take action on six bills concerning water, none of which had any great impact on the control or use of the water resources of Nevada. The last two acts passed by the legislature (Chapters 112 and 113) indicated an attempt by the legislature to provide means to use the water resources of the State for irrigation purposes. Both acts were repealed shortly thereafter.

Chapter 15

This act prohibited the throwing and deposit of sawdust in or on the water of any lake, river, or running stream in the State. Any person violating the provision of the act would be guilty of a misdemeanor.

Chapter 48

This act was aimed at preventing the unlawful diversion or waste of water during the irrigation season. It was provided that anyone, during the irrigation season, who directs the water, or portion thereof, from any river and stream into any slough or pond, and makes no beneficial use of such waters, or who allows the water to run to waste on sagebrush or greasewood land, would be guilty of a misdemeanor. This act is still applicable.

Chapter 78

Under this act any owner or superintendent of any water ditch or artificial water course who allows the water from such ditch or water course to run uncontrolled upon any public road so as to make such roadway impassable or inconvenient to travel, was subject to a fine not less than \$10 nor more than \$100.

Chapter 104

Section 3 of the 1866 Act was amended to provide that a person maintaining a ditch would have the undisputed right of flowing water through the same to the full extent of its capacity for mining, milling, manufacturing, agriculture, and other domestic purposes, but not to the extent of interfering with existing rights.

Chapter 112

This act was an elaborate effort on the part of the 1889 legislature to provide for the storage of water, to reclaim the arable lands of the State, to develop the agricultural resources of Nevada, and to provide the necessary funds.

Even though this act was repealed in the following legislature in 1891, the author has outlined some of the provisions, as it indicates the interest of the legislators to develop the water resources of the State and to use the large land grants from the Federal Government to the State of Nevada for the purpose of irrigated agriculture.

The "Whereas's" preceding Section 1 of the act laid the ground work for the act. These are, in brief, as follows:

WHEREAS, The State of Nevada has received from the General Government a grant of two million acres of land in lieu of the sixteenth and thirty-sixth sections, previously granted . . . ; and

WHEREAS, Under an Act of Congress, approved September 4, 1841, and an Act approved March 21, 1864, a grant of 500,000 acres of land was made to the State of Nevada for internal improvements; and

WHEREAS, The selection of lands are not confined to any particular section of unappropriated lands; and

WHEREAS, The greater portion of unappropriated lands in the State of Nevada is known to be desert, waste and actually valueless and without sale, unless water, for the purpose of irrigation, can be brought upon them . . . ; and

WHEREAS, the permanent settlement, growth, wealth and independence of the State and people . . . , depend upon the reclamation of those desert lands."

Under this act, a Board of Reclamation Commissioners, consisting of four members, was created, and the State of Nevada was divided into seven Internal Improvement and Reclamation Districts. The board, as well as the surveyor general, were given a number of responsibilities requiring considerable expenses for which no funds were appropriated in the act to pay for such services. Briefly, the more important services to be rendered were:

- to procure information and statistics in regard to all public lands and the waters running thereon.
- to publish facts and statistics regarding the natural water courses and other matters relating to the more practical methods of utilizing such water.
- the surveyor general to furnish the Board of Reclamation Commissioners, profiles and estimates as to the most feasible and least costly routes for canals, etc.
- the works of construction on canals, dams, etc., to be done by contracts awarded by the board.
- to employ a competent civil engineer to report the number of irrigation ditches in each reclamation district, their capacity, and the amount of water theretofore appropriated and used.
- the purchase or rent of such lands needed for reservoirs or ditches as may be deemed best.
- on petition of 10 or more persons interested in irrigation ditches in any district, for the issuance of bonds for reclamation purposes, to submit the question to the voters of said district.
- to advertise and receive bids for reclamation works as soon as the surveyor general has made the necessary surveys, maps, etc.
- to limit the total cost of any canal, ditch, dam, or other works to \$100,000.

- to take the money from state school funds and in its place deposit 100 bonds of \$1,000 each at 4 percent per annum interest.
- to levy and collect for the following fiscal year, and annually thereafter, an ad valorem tax of 2 cents on each \$100 of all taxable property in the State, to go into the reclamation interest and sinking fund, for the payment of interest and redemption of bonds.

This act specified that the elective members of the board would receive traveling expenses but no compensation for their services. No money was provided for administration purposes.

Chapter 62, Statutes of 1891, repealed this law. No records could be found by the author as to any action taken by the Board of Reclamation Commissioners during the 2 years prior to its repeal.

Mention was made earlier of the 2-million-acre and 500,000-acre grants by the Federal Government to the State of Nevada. These grants, as well as others, played an important role in the history of Nevada. As the desert lands and water resources have been closely related, the author presents a brief history of such grants as reported on by the various surveyors general in appendix 2.

Chapter 113

This act was designed to regulate the use of water for irrigation and other purposes: to settle the priority of water rights, to provide for the condemnation of land for reservoirs, to record claims to water rights, and to appoint water commissioners.

Chapter 113 was enacted into law on March 9, 1889, the same day Chapter 112 was, but its authority extended 2 years longer. It contained 33 sections, some of which were lengthy and somewhat cumbersome. It did, however, indicate the increased interest of protecting the control and use of water for irrigation purposes. This was, no doubt, brought about by the great expansion of irrigated lands along the Carson, Walker, Truckee, Humboldt, and Muddy rivers, their tributaries, and many smaller streams.

The State was divided into seven districts with provisions for one water commissioner, if needed, in each. The district courts in each district were vested with the jurisdiction of hearing all questions concerning priorities and adjudicating water rights.

The only provision that proved valuable, in the short life of this law, was contained in Section 9, which required that any user of water must, prior to September 1, 1889, file with the proper county recorder a statement, under oath, giving the pertinent data regarding his diversion and use of water. It was required that the county recorder prepare an index of such claims in a book provided for that purpose.

Section 12 provided that any person intending to appropriate water and before the commencement of any work must file with the county recorder a statement giving the pertinent data as to source, point of diversion, and place of use.

The act further set up a procedure for the determination of the priorities of water rights by the proper district court and for the issuance of certificates of appropriation. This act (Chapter 113) was repealed by Chapter 127, Statutes of 1893.

1891

Chapter 92

This law provided a procedure for the organization of irrigation districts. Under this act, owners of lands susceptible to irrigation from a common source and by the same system of diversion works, if found desirable, could band together so that better and more efficient use of water for irrigation could be made and the owners could propose the organization of an irrigation district.

A petition was to be first made to the Board of County Commissioners, followed by hearings before the board. An election was then to be held, and if at least two-thirds of all votes cast favored such an irrigation district, the said board would declare such territory duly organized.

1893

Chapter 64

The only act regarding water approved by the 1893 legislature was a very restrictive piece of legislation. It provided that in all counties containing a voting population of not less than 375 nor more than 425, as determined by the total vote for presidential electors at the last general election, the several Boards of County Commissioners were authorized to build dams in and change the channel or course of any river and waterway, whenever it appeared necessary to prevent damage to or destruction of taxable property. Whenever the board was unable to secure the necessary land for such construction, it could proceed to appropriate such property under the provisions of acts of 1866 as amended in 1869 heretofore mentioned. Any Board of County Commissioners in counties where this act was applicable was limited to an expenditure of not more than \$1,000.

This piece of legislation was written for several counties. The author made no attempt to determine which counties met the voting population requirement, although the total population as determined by the U.S. Census Bureau suggests that Douglas County might have been one.

1899

Chapter 38

Under this act, the 1891 act providing for the organization of an irrigation district was amended as to the procedure relating to the petition by the water users and the election process required for the formation of the district or election of officers.

Chapter 49

This chapter provided that any water stored for irrigation or other beneficial purposes could be turned into the channel of any natural stream or water course and mingled with those waters and then reclaimed. However, when the water is reclaimed, water already appropriated by others from such stream or water course must not be diminished in quantity. This statute is still applicable.

Chapter 61

Under the provisions of this act, Washoe County was empowered to purchase, for the use of the people of Washoe County, reservoir sites situated east of the Sierra Nevada. The act provided that the matter as to purchase must be submitted to the people for consideration at the next general election. If the people voted in favor of such purchase, the county could issue bonds to be redeemed within 30 years.

In the first biennial report of the State Engineer, dated December 31, 1904, State Engineer A.E. Chandler wrote:

"For a number of years systematic measurements of the discharge of both Truckee and Carson Rivers have been carried on at several different points for the purpose of determining the character and quantity of their water supply. Since 1900 numerous surveys of reservoir sites have been made at points where it appeared practicable to impound flood waters to aid in regulating the stream flow. In the basin of the Truckee seven of these reservoirs surveyed are recommended for construction, and estimates of their costs have been prepared. In the basin of Carson River twenty-one storage sites were examined, of which four only are recommended for construction."

Chapter 97

The law created under Chapter 97 was an attempt by the legislature to define and preserve existing water rights, to provide a method of acquiring new appropriations of water, and for the storage of surplus water.

During this period, several western states had enacted water laws vesting the authority to carry out the provisions of the law by a State Engineer or some other State entity. In this act, the Nevada State Legislature seemingly adopted some of the provisions of other states concerning the status of water, its ownership, protection of existing rights, and the acquisition of new rights. However, instead of vesting the authority to carry out its provisions in a State agency, it allowed the counties to create a Board of Water Commissioners, giving the respective county surveyors the duty of performing the several duties required by such law, under the direction of the individual Boards of Water Commissioners.

The first seven sections of this act set forth the policy regarding the water resources of Nevada. This policy, with some revisions, still applies. The principal policies contained in Chapter 97, Statute of 1899, were:

SECTION 1. All natural water courses and natural lakes, and the waters thereof which are not held in private ownership, belong to the State, and are subject to regulation and control by the State.

SECTION 2. All existing rights to the use of water, whether acquired by appropriation or otherwise, shall be respected and preserved. . .

SECTION 3. There is no absolute property in the waters of a natural water course or natural lake. No right can be acquired to such waters except as usufructuary right--the right to use it...

In such counties where a Board was created, the county surveyor, when petitioned by a majority of the freeholders whose lands were situated within a certain watershed, was required to determine the discharge of streams from which water could be diverted, carrying capacity of the various ditches, lands irrigated, and any surplus water. It became the duty of the county surveyor to report to the Board of Water Commissioners.

Any person thereafter desiring to appropriate water was required to make application to the county surveyor, who, after an investigation, reported his findings to the Board of Water Commissioners who then could approve or reject the application. Provisions were made for an appeal to the district court. The act left to the discretion of the Board of County Commissioners as to whether or not it would form a Board of Water Commissioners.

Other provisions were that any diversion of water be limited to the amount that could be beneficially used, that appropriators were allowed to change the manner or place of use, and that a cubic foot of water for a given period of time be the standard measurement.

Section 8 of the act created a Board of Water Commissioners consisting of the county commissioners and the county surveyor of each county. (As previously noted, that part of the act relating to the Board of Water Commissioners and their creation in each county and district was left to the discretion of each Board of County Commissioners. What counties in the State, if any, took advantage of this legislation was not determined by the author--possibly none.) In Section 9, the board was given the authority to require the respective county surveyor to carry out the provisions of the act. Even with the passage of this act, the 1866 act as amended remained the only control of all new appropriations of water.

1901

During the 1901 legislative year, only two bills concerning water were enacted into law; one concerned surface water and the other offered a bonus for drilling wells to obtain oil, gas, or flowing water. This latter act (Chapter 76, Statutes of 1901) is discussed in the section on ground-water legislation.

Chapter 59

This law provided for the measurement of the discharge of streams, examination for storage reservoirs, determination of irrigation possibilities, and the best methods of controlling and utilizing the water resources of the State. The act also created a State Board of Irrigation consisting of the Governor, surveyor general, and the attorney general. The main function of the State Board of Irrigation was to direct the expenditure of the appropriated money.

Section 1 of the act provided \$4,000 to carry out the provisions of the act during 1901 and 1902. Of this amount \$2,000 was earmarked for the U.S. Geological Survey in charge of hydrography, and the other \$2,000 was credited to the U.S. Department of Agriculture for irrigation investigations in cooperation with the Nevada Agricultural Experiment Station.

A provision included in the act was the stipulation that the \$4,000 State appropriation must be matched with an equal or greater Federal appropriation. This may have been the first cooperative matching program with the U.S. Geological Survey--a program that, with the exception of the years 1908-12, has been continuous. This provision has resulted in a successful and comprehensive cooperative surface-water resource study program and some years later the cooperative ground-water resource study program.

1903

The legislative session of 1903 was a memorable one in the water law history of Nevada in that the Office of State Engineer was created. For the first time, in its struggle to solve water problems, to protect existing water rights, and to bring about of a better method to utilize water resources, the State established a centralized department under the control of the State.

Chapter 4

This act was the start of a new era in the determination, protection, and administration of water rights as appropriated under the 1866 act (Chapter 100, Statutes of 1866, amended Chapter 77, Statutes of 1869). It also provided for the cooperation of the State of Nevada with the Secretary of the Interior in the construction and administration of irrigation works for the reclamation of arid lands in the State of Nevada, under the Reclamation Act approved by Congress June 17, 1902.

Irrigation Law of 1903

The incentive to the passage of the Irrigation Law of 1903 was two-fold: First and most urgent was the desire and early necessity of the State of Nevada to cooperate in every way with the Secretary of the Interior in the construction, operation, and management of the Truckee-Carson Irrigation Project. Then, second was to provide a method whereby existing rights to water might be defined before conditions became more acute. It was clearly evident that reclamation work by the United States Government could not proceed unless existing rights to the use of water were ascertained.

The preamble to the Irrigation Law of 1903 creating the Office of State Engineer listed a number of sections contained in the 1902 Reclamation Act as well as a number of "Whereas's," pledging the cooperation of the State of Nevada to meet its obligation required by the Reclamation Act. Mention is made of a few of the pertinent sections of that act:

"That all moneys received from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming . . . set aside and appropriated as a special fund in the Treasury to be known as the "reclamation fund," to be used in the examination and survey for and the construction and maintenance of irrigation works . . .

SECTION 2. That the Secretary of the Interior is hereby authorized and directed to make examinations and surveys . . .

SECTION 4. That upon determination by the Secretary of the Interior that any irrigation project is practicable, he may cause to be let contracts for the construction of the same, . . .

SECTION 8. That nothing in this Act shall be construed as affecting . . . or to in any way interfere with the laws of any State . . . And,

WHEREAS, The Secretary of the Interior of the United States, acting by and through the United States Geological Survey, has entered upon the examination, survey and location of irrigation works on the Truckee, Carson, Walker and Humboldt Rivers . . .

WHEREAS, A sum approximating ten million dollars is now collected in a special fund . . . known as the "Reclamation Fund" . . .

WHEREAS, It is essential that the Secretary of the Interior, before proceeding to actual construction on any river in Nevada, shall be informed as to the extent of its present actual appropriation and beneficial use of water . . ."

Following the preamble the Irrigation Law of 1903 consisting of 23 sections, was set forth. The main features of this act were the creation of the Office of State Engineer and setting forth a method for a speedy adjudication of existing water rights. Absent from this legislation was any provision to control new appropriations.

Section 3 of the 1903 act created the Office of State Engineer, who was to be appointed by the Governor and to have a salary of \$2,400. In setting forth the qualifications, it is interesting to note that the Secretary of the Interior or the Director of the U.S. Geological Survey was given 30 days to approve a name submitted to become State Engineer. If no action were taken by the government officials, the Governor could proceed to make the appointment.

Section 6 allows the State Engineer to appoint an assistant at a salary of \$1,200 per annum. The State Engineer was also empowered to appoint as assistants persons in the service of the U.S. Geological Survey who worked in Nevada, but without any pay from the State.

Sections 9 through 14 of the Nevada Irrigation Law of 1903 required the State Engineer to prepare for each stream in the State a list of appropriations of water according to priority, and in order to make such list he was required to send a form on which the claimant should present in writing the necessary data to substantiate his claim. Following this, an examination was to be made of the stream system and diversion works and a record was to be compiled of such in his office. Within 30 days after such preparation, the State Engineer was required to issue a certificate to each water user. Provision was made for any person not satisfied with the finding of the State Engineer, to bring action in the appropriate district court.

Section 16 required all county recorders to prepare a full transcript of all claims of appropriation of water previously filed in such office, and to supply the transcript to the State Engineer.

The State Engineer was made a member of the State Board of Irrigation which was created by the legislature in 1901 (Chapter 59, Section 17).

Truckee-Carson Irrigation Project--The Newlands Project

On the basis of a full reading of the "Whereas's" in the Irrigation Law of 1903, it is evident that the Secretary of the Interior had been making similar surveys and studies in other western states and territories and that every effort was being made by the Nevada State Legislature to be the first state, or at least one of the first, to take advantage of the Reclamation Act. No doubt, the 1903 authorization of the Truckee-Carson Irrigation Project in Nevada was in recognition of U.S. Senator Francis G. Newlands who, as a Nevada Congressman, was one of the main sponsors of the Reclamation Act. In 1919, the project was renamed the Newlands Project in his honor.

The Newlands Project was, in some respects, the first reclamation project in the United States under the 1902 Reclamation Act. There has been some question as to whether the Salt River Project in Arizona or the Truckee-Carson Irrigation Project in Nevada was first. In the 1948 edition of *Reclamation Project Data*, edited by Michael W. Straus, Commissioner of Reclamation, it was stated that the Truckee-Carson Project (Newlands Project) was among the first five to be recommended by the Director of the U.S. Reclamation Service (now known as the Bureau of Reclamation) in 1903. The Secretary of the Interior authorized the project March 14, 1903, and the first water became available April 1, 1905.

Commissioner Straus, in referring to the Salt River Project, stated that it was authorized by the Secretary of the Interior on March 14, 1903, and that construction began August 24, 1903, with the first water under the project becoming available May 15, 1907, 2 years after the Truckee-Carson project. State Engineer A.E. Chandler, describing the various features of the latter project, indicated in the 1903-04 Biennial Report that construction on a segment of the Truckee-Carson project started on September 11, 1903, about 2 weeks following the first construction on the Salt River Project.

The Derby Dam on the Truckee River, which still diverts water from the Truckee River through a 31-mile canal to the Carson River, was completed in June 1905, thus being the first structure to be finished under the Reclamation Act of 1902.¹

First State Engineer

The first State Engineer for Nevada, appointed by Governor John Sparks, was A.E. Chandler, who took office May 29, 1903. As State Engineer, Mr. Chandler stated that the most important work of the State Engineer was the determination of the priority of water rights. Other duties, like the gaging of streams and the mapping of irrigated lands, were but preliminary to this.

Section 9 of the Irrigation Law of 1903 provided that the State Engineer, in order to make a list of appropriations of water according to priority, "shall enclose to each person having a claim to the water of such stream a blank form on which said claimant shall present in writing all the particulars showing the amounts and dates of appropriation. . . ."

In order to assist the claimants of water use on the East and West Forks of the Carson River, the State Engineer personally visited every water user. Mr. Chandler stated that by the end of 1904 all the proofs of appropriations for the Upper Carson Valley had been filed in the Office of State Engineer. In his biennial report for the years 1903 and 1904, dated December 31, 1904, Chandler made suggestions for supplemental legislation that would give the State Engineer the administrative control of new water appropriation. This became the basis for the 1905 amendments to the 1903 Irrigation Law.

¹ Glass, Mary Ellen, 1964, *Water for Nevada--The reclamation controversy, 1885-1902*: Reno, University of Nevada Press, 62 p.

Chapter 47

This act was similar to the aforementioned act approved in 1901 (Chapter 59) and provided for the measurement of water on irrigated lands, ditch losses, and the study of the best methods of distribution and use of water. The sum of \$2,000 was appropriated to be matched by the U.S. Department of Agriculture. The cooperative program was to be carried on by the U.S. Department of Agriculture and the Nevada Agricultural Experiment Station.

The act also provided that the State Board of Irrigation, created by Chapter 59, Statutes of 1901, would direct the expenditure of the State appropriation.

Chapter 122

In this chapter the legislature provided a very stringent law to prevent the pollution of the public waters of the State. The act provided:

SECTION 1. Any person or persons, firm, company . . . in this State, who shall deposit . . . in any of the waters of the lakes, rivers, streams and ditches in this State any sawdust, rubbish, filth, . . . shall be deemed guilty of a misdemeanor . . .

SECTION 3. The sum of three thousand dollars is hereby appropriated . . . for the purpose of enforcing the provisions of this Act, . . .

1905

Chapter 46

Early in the legislative sessions of 1905 the legislature approved an act, contained in Chapter 46, that provided that any person desiring to appropriate water must file with the State Engineer for a permit to appropriate. This act amended the Irrigation Act of 1903 that established the Office of State Engineer and provided a method to adjudicate existing water rights. This amendment was contained in six new sections.

Briefly, it was provided that any person or association desiring to appropriate water should, before performing any work, make an application to the State Engineer for permission to make the same. The application form was to contain certain information as to the source, location of proposed works, amount of water needed, purpose for which the water was to be used, and other information required by the State Engineer.

Protests could be filed by any other water user who obtained a supply from the same source. If the State Engineer found that there was unappropriated water he could grant a permit. Within 6 months following such approval the applicant was required to file a map in support of such application. Upon satisfactory proof that the application had been perfected the State Engineer could issue a certificate of appropriation.

The second State Engineer appointed by Governor John Sparks, Mr. Henry Thurtell, in his 1905-06 Biennial Report, stated that from May through December 1905, only 31 applications to appropriate water were filed. In 1906, however, 291 such applications were filed.

Incidentally, the first application filed under the new law was in 1905 by A.C. Pratt to appropriate water from the East Fork of the Carson River for power purposes. It was approved and subsequently cancelled. The second application was by the H.F. Dangberg Land and Livestock Company, for water from the East Fork of the Carson River for irrigation purposes. It was approved and later cancelled. The third application was by H.C. Dangberg from the same source for irrigation. It was approved and a certificate of water rights was issued January 1, 1910.

1907

Chapter 18

This act, approved February 26, 1907, repealed the Irrigation Law of 1903, which created the Office of State Engineer and provided a statutory method to determine existing water rights (Chapter 4, Statutes of 1903), and the amendatory act of 1905 (Chapter 46, Statutes of 1905), which provided a method for the appropriation of new water rights. However, the 1907 act, creating a new water law, did not differ in any essential particulars from the acts of 1903 as amended in 1905.

The 1907 act contained additional provisions regarding applications to appropriate water; the principal additions provided (1) a method to change the point of diversion and place of use of water already appropriated; (2) a method for aggrieved parties to bring action against a decision of the State Engineer; and (3) a procedure to fine or imprison anyone found guilty of a misdemeanor by this statute. The method of adjudicating vested water rights remained the same.

The 1907 act made the State Engineer a member and secretary of the State Board of Irrigation which was created by Chapter 59, Statutes of 1901. Provisions were made for the board to divide the State into water districts with the authority to appoint water commissioners.

Chapter 57

This act amended the pollution act of 1903 (Chapter 57) in order to give State institutions, municipalities, and towns an additional extension of 4 years to correct the condition causing pollution. In the 1903 act, such agencies were given 4 years from date of passage (that is, until March 20, 1907) to make the necessary repairs.

Chapter 199

Provisions were made in this act for a cooperative program between the U.S. Department of Agriculture and the Nevada Agricultural Experiment Station. A sum of \$2,000 was appropriated by the State to be matched with a like sum from the U.S. Department of Agriculture, for the years 1907 and 1908.

The purpose of the act was for the measurement of water used on irrigated areas, the determination of the losses from irrigating ditches and the remedies therefore, and the study of the best methods of distributing and using water for growing crops in the State of Nevada. Under the act, the investigations were to be made by the agents of the U.S. Department of Agriculture. The results of the investigations were to be reported to the State Board of Irrigation.

1909

During the biennial period 1909-10 there were four legislative acts that pertained to the function of the State Engineer. These acts, contained in Chapters 31, 45, 81, and 164, briefly were as follows:

Chapter 31

This act amended the Irrigation Law of 1907 providing for the maximum quantity of water which could be appropriated for irrigation purpose, the cancellation of an application to appropriate water under certain conditions, and a new fee schedule.

Chapter 45

This legislation provided that any person interfering with storage and diversion works without authority from the owner of the same, except under the authority of the State Engineer, would be guilty of a misdemeanor and subject to a fine of \$100.

Chapter 81

Provisions were made in this act that required anyone using the public water of Nevada under a permit or certificate to install and maintain a headgate and measuring unit near the point of diversion.

Chapter 164

This legislation provided the means for the State of Nevada to comply with the provisions of the Acts of Congress approved August 18, 1894, known as the Carey Act. The purpose of the act was to aid the public-land States in the reclamation of desert lands. Although this congressional act was expected to be a major milestone in reclamation by irrigation, with one or two notable exceptions, it did not measure up to expectations.

Even though the operation of the Carey Act in Nevada was, with one small exception, a dismal failure, its history in Nevada is an interesting one. Its history is related more fully in appendix 3.

1911

During the legislative session of 1911, two laws were approved which were related to the State's obligations in carrying out the provisions of the Carey Act.

Chapter 74

This act created the Bureau of Industry, Agriculture, and Irrigation, consisting of the Governor, surveyor general, attorney general, State Engineer, and one other member appointed by the Governor. The main purposes of this commission were to make a study of industrial, irrigation, and reclamation problems; to carry on explorations and experiments to determine the feasibility of reclaiming favorable areas of the State by utilizing the subsurface waters; and to have control of the selection, management, and disposal of all lands granted to the State under the provisions of the Carey Act.

Chapter 76

This act also related to the Carey Act, which gave the State Commission of Industry, Agriculture, and Irrigation the control of the selection, management, and disposal of all lands granted the State under the provisions thereof.

Elaborate rules and regulations of the State Commission of Industry, Agriculture, and Irrigation bearing on the duties of the State Engineer, were adopted April 27, 1911, a little more than a month following the enactment of Chapters 74 and 76. Their rules are set forth in the 1911-12 Biennial Report by State Engineer W.M. Kearney.

Chapter 141

This act provided for a cooperative program between the U.S. Department of Agriculture and the State of Nevada, represented by the Nevada Agricultural Experiment Station and the State Engineer. The scope of the program included the measurement of water on irrigated lands and studies of the best method of applying water to growing crops. The sum of \$4,000 was appropriated to match Federal funds for the 1911 and 1912 growing seasons.

1913

The legislative session of 1913 marked another landmark in the long history of developing a Nevada water law. It was in this session that the present general water law (Chapter 140) was approved. This law, in addition to providing the foundation of the present general water law, was also first cognizance of underground water by the legislature.

Chapter 140

This act repealed the water laws of 1907 (Chapter 18) and the amendatory act of 1909 (Chapter 31), together with all other acts in conflict. This new water law was greatly broadened both as to the adjudication procedure of vested rights (rights acquired prior to March 1, 1905) and the appropriation procedure, subsequent to the above date, of application to the State Engineer for a permit to appropriate water.

Subsequent to 1913, many amendments to the water law of 1913 were approved, as well as new sections added, in order to fit the law to developing conditions.

It is not the intention of the author to further comment on the general water law as it now stands; it has been well established. However, the development of laws affecting ground water are noted up to the enactment of the Underground Water Act of 1939.

Two miscellaneous acts which involve the State Engineer are briefly related, as they add to the interesting history of the development of law relating to the conservation and use of the water resources of Nevada.

Chapter 174

This act provides that no permit for the application of water should be denied because the point of diversion or any portion of the works of diversion or intended use of such water are situated in another State, provided such State authorizes the diversion of water for use in Nevada.

Chapter 181

Provision is made in this act for a cooperative program between the U.S. Geological Survey and the State Engineer for an investigation of the water resources of the State. This act provides a resumption of the stream-gaging program discontinued during 1908.

The work of stream measurement by the U.S. Geological Survey on a 50-50 cost-matching basis has continued through the years with outstanding results.

NEVADA'S GROUND-WATER LAWS

Legislative Foundations

From Nevada statehood, October 31, 1864, to the end of the 19th century, legislation relating to water lying beneath the surface of the ground, that is ground water or underground water, was limited to two acts, both of which provided a bounty to the person drilling a well and both relating to free-flowing artesian water. These acts were contained in Chapter 82, Statutes of 1879, and Chapter 127, Statutes of 1887.

Following the turn of the century, the first legislation pertaining to underground water was enacted in 1901 (Chapter 76). This act provided a bounty for drilling a well for oil, natural gas, or flowing artesian water.

In 1905, Chapter 151 provided that the State set aside \$4,500 for the drilling of wells in southern Nevada, as an aid to the prospectors in their search for precious metals.

No further legislation was enacted applying to underground water until 1913, when language contained in Chapter 13 allowed each county in the State to acquire real estate in favorable locations and to sink a well or wells for artesian water at a yearly cost to a county not to exceed \$5,000. During the legislative session of 1915, another act (Chapter 111) supplemented the 1913 act by obligating the State to assume such costs.

On March 7, 1913, the first legislation was enacted, Chapter 54, which provided a law for the conservation of underground water and for the casing and capping of artesian wells. After reading this act, it seems reasonable to assume that the legislators were concerned solely with water waste from free-flowing wells.

About 2 weeks later, March 22, 1913, the general water law was enacted, Chapter 140, Statutes of 1913. For the first time, the legislature recognized water lying beneath the surface of the ground as being subject to the laws of the State as to appropriation.

As an indication of the interest of the Nevada State Legislature in the development of underground water, mention is made of the act creating the Department of Engineering Experimentation within the University of Nevada. This act, contained in Chapter 97, Statutes of 1915, provided a fund of \$5,000 for the department to provide aid to farmers and other persons who desired to develop underground water.

Another law (Chapter 210), enacted March 24, 1915, was similar to the 1913 act (Chapter 54), both of which applied to the conservation of underground water. Section 1 of the 1915 act excepts "percolating water" from the law applying to the appropriation of water under the general water law of the State (Chapter 140, Statutes of 1913). The matter of percolating water is discussed later.

No further legislation specifically directed to underground water was enacted until 1935 when an amendment was made to the above noted 1915 act (Chapter 210). This amendment contained in Chapter 184, Statutes of 1935, placed the administration of the act in the hands of the State Engineer, and provided for the prevention of loss of underground water above and below the ground surface.

During the following session of the legislature in 1937, another amendment to the 1915 act was enacted into law (Chapter 149). Its main provisions were that in a proven artesian basin anyone desiring to bore a well must first secure from the State Engineer a permit to appropriate water. It required that a well log must be kept and gave the State Engineer the right to make reasonable rules and regulations.

Both the above noted 1935 and 1937 amendments were sponsored by Clark County. With the enactment of the 1939 Underground Water Act, the 1915 act (Chapter 210) and the 1935 and 1937 amendments were repealed.

On March 25, 1939, a comprehensive underground water law was enacted by the legislature: Chapter 178, Statutes of 1939. During subsequent years, a number of amendments were added. A more detailed analysis of this act is set forth later.

Major legislation that affected the early development of Nevada's ground-water resources is described below and summarized in table 1.

1879

Chapter 82

During the 1879 session of the Nevada State Legislature, an act was approved which provided that a county could pay a bounty for the sinking of an artesian well.

Under the terms of this act, any person who drilled a well was entitled to receive a bounty of \$2 per foot after the first 500 feet had been reached. The act specified that prior to reaching a depth of 500 feet such person must file, with the county recorder, a proper description of the location, size of casing, and the then depth of the drilled well; further, that such person was intending to drill an artesian well more than 500 feet in depth. Following the completion of such well to a depth greater than 500 feet and if the well flowed, the well owner was required to advise the Board of County Commissioners of such fact; the board would authorize an examination, and if the conditions were met, the well owner could demand \$2 for each foot of drilled well beyond the 500-foot depth. Such bounty would be paid from the general fund of the county.

Another section of the act provided that if prior to the passage of the act, a person had commenced to drill an artesian well and had reached a depth of 300 feet, such person would be entitled to such bounty of \$2 per foot beyond the 300-foot depth, provided that a flowing well had been developed.

It is difficult to understand the practical nature of this act. Certainly, it would not have been too attractive to many farmers seeking a free-flowing well for irrigation. It would seem that the legislature intended to give well owners some incentive to continue with their drilling if no flowing water was encountered at the 300- or 500-foot depth, as the case may be, in the hopes of obtaining a flowing well.

1887

Chapter 127

Eight years following the enactment of Chapter 82, another act, which was much more liberal in its provisions than the 1879 act, was approved by the Nevada State Legislature that provided a bounty for drilling a free-flowing artesian well. The main provisions set forth were that the person desiring to comply with the act, before commencing to sink such artesian well, must file with the county recorder a sworn statement giving the location of the well site. Further, before being eligible for the bounty, such well would have to flow at least 7,000 gallons of water per day continuously for 30 days. The bounty, amounting to \$1.25 per foot, would be a charge against State funds. Other provisions were that the bounty would not be paid on more than three wells in any one county within the State and that no two wells would receive a bounty if located within 10 miles of each other. The sum of \$10,000 was appropriated out of the general fund of the State. No doubt the reasons behind the enactment of the legislation providing bounties for producing free-flowing wells was to encourage the development of underground water in areas where surface water was not available.

Although this act, along with the 1879 act, was not repealed until 1957, it is quite possible that the provision of the 1887 act could have been met in a number of cases. The 7,000 gallons per day of flowing water represents a flow of only about 5 gallons per minute. In many of the valleys of Nevada, such as Las Vegas, Smith, Carson, Eagle, and Washoe, flowing artesian water was obtainable, in many instances, at depths as shallow as 100 feet.

It would seem during those early years, and even as late as 1915, the legislature construed artesian wells as only those having a free flow not as those in which the static water level is above the level first encountered during drilling but is nonflowing. Nonflowing artesian wells were later recognized.

1901

Chapter 76

It was not until 1901 that the legislature again took steps to engender some interest in the underground water resources of the State by drilling of deep wells. Chapter 76, Statutes of 1901, was unique in its provisions, and for the interest of the reader the salient points are herewith set forth. Section 1 of this act reads:

"Any person who first produces five barrels of crude petroleum that is the natural product of the State of Nevada shall receive as a bounty from the State the sum of one thousand (\$1,000) dollars. The person who first discovers natural gas in the State of Nevada to the extent of no less than one thousand cubic feet shall receive a bounty of one thousand (\$1,000) dollars from the State. The first person to sink a well in the State of Nevada not less than six inches in diameter at the bottom, to the depth of one thousand (1,000) feet shall receive a bounty of twenty-five hundred (\$2,500) dollars from the State; provided, that such well shall flow at least sixty gallons of water per minute."

Section 2 of this act provides the steps to be taken by a person who believes he has fulfilled one of the provisions set forth in Section 1. Section 3 reads as follows:

"Any person receiving a bounty under this Act shall enter into a contract with the State that he or she will, in case the oil, gas or water found is developed in sufficient quantities to become marketable or is sold in any way or bartered for any valuable consideration, that the party so disposing of it shall reimburse the State to the full extent of the bounty received."

The sum of \$5,000 dollars was appropriated additionally to carry out this act. This act remained in force until it was repealed by the legislature in 1921 (Chapter 195, Statutes of 1921). In 1907 and 1908 the first two wells were drilled in Nevada for oil or gas, and both were drilled in Washoe County. The 1907 well reached a depth of 1,890 feet with a reported showing of gas; no data were given for the 1908 well as to depth except that it reportedly had no showing of oil or gas. A shallow well was reportedly drilled during 1907 in Lyon County and had no showings of oil or gas.¹

1905

Chapter 151

This act was specialized legislation and applied only to developing an underground water source as an aid to the prospector in search of ore in several counties in southern Nevada. The counties to which the act applied were Esmeralda, Nye, Lincoln, Eureka, Lander, and White Pine. At that time, Clark County had not been carved out of Lincoln County, and Esmeralda County had not been divided to form Mineral County.

The act provided an appropriation of \$4,500 for the seeking, boring, and development of wells in the above-mentioned counties, with the proviso that \$1,000 could be expended in each of Esmeralda, Nye, and Lincoln Counties, and \$500 in each of Eureka, Lander, and White Pine Counties. The purpose, as set forth in the act gave the county commissioners in the several counties the right to drill wells at such points where water was likely to be found, as would best "subserve the interests and needs of prospectors, miners, freighters, stage lines, and travelers generally."

1913

Chapter 13

It was not until 1913 that the legislature approved another act pertaining exclusively to the encouragement of drilling artesian wells at selected areas. The act authorized the Board of County Commissioners of each county to acquire by gift or purchase, in the name of the county, real estate favorably situated for prospecting artesian water. Following the acquisition of not less than 40 acres, the Board of County Commissioners was authorized to sink, upon one or more of said pieces or tracts of land, an artesian well. No county could, during any 1 year, expend more than \$5,000 in sinking artesian wells. The expense of sinking such artesian wells was to be a legal charge against the county in which the wells were sunk. This act, together with a companion 1915 act (Chapter 111), was not repealed until 1957 (Chapter 383).

¹ Lintz, Joseph, Jr., 1957, Nevada oil and gas drilling data, 1906-1953: Nevada Bureau of Mines Bulletin 52, 80 p.

Chapter 54

On March 7, 1913, two weeks prior to the passage of a general water law for Nevada, the legislature approved a law for the conservation of underground waters in the State of Nevada. This act applied only to the sinking of artesian wells which were required to have sufficient casing to prevent the caving in of such well and the necessary valves to prevent and control the flow of water.

Other provisions were that no person controlling an artesian well should allow the water therefrom to escape, save for beneficial uses. Any police officer of a city, county, or the State of Nevada, upon complaint of any person that the owner of an artesian well was allowing the water to run to waste, could enter upon the premise where the well was situated for inspection, and if the findings show noncompliance with the provisions of the act, criminal action could be instituted.

The act makes no mention of any obligation on the part of the State Engineer. It would seem that all artesian wells as described under this act were still considered to be free-flowing wells.

Chapter 140

On March 22, 1913, two weeks following the foregoing underground conservation act, the legislature approved the so-called 1913 General Water Law. This legislation became the foundation of the present general water law. For the first time underground water was included as coming under the provision of the water law relative to the appropriation thereof by filing with the State Engineer an application to appropriate.

Section 1 of this act provided that:

"The water of all sources of water supply within the boundaries of the State, whether above or beneath the surface of the ground, belongs to the public."

Section 2 provided:

"Subject to existing rights, all such water may be appropriated for beneficial use as provided in this Act and not otherwise."

It seems clear that the intent of the legislature was to include all underground water, whether artesian or non-artesian and wherever located, as coming under the provisions of this act.

1915

Chapter 97

Although this act did not apply to the underground-water law and the work of the State Engineer, it nevertheless shows that the legislature was becoming aware of the importance of utilizing the underground water of the State and of providing ways of aiding settlers. Under this act a Department of Engineering Experimentation was created within the University of Nevada system and was to devote its efforts to the aiding of settlers, farmers, and other persons desiring to develop underground water. A sum of \$5,000 was appropriated for this purpose. The Board of Regents of the University of Nevada was empowered to appoint a director to supervise the work. Such director was required to advise and assist in matters relating to the most feasible method of developing underground water.

This act was repealed in 1917 (Chapter 64). No reason was found for the repeal. Conceivably, it may have been that the University of Nevada Agricultural Experiment Station carried on this work under its own direction and expense, hence the need no longer existed for a separate Department of Engineering Experimentation. However, it is of interest to note that the legislature included in its 1917 appropriations an

item of \$5,000 in the budget of the State Engineer for such experimentation. State Engineer Seymour Case, in his 1917-18 Biennial Report, stated that it was no doubt intended that the money should be expended for the purposes defined in the 1915 act (Chapter 97).

Mr. Case further reported that he had engaged the service of Ira McFarland to carry on this work and that during the summer of 1917, Mr. McFarland gave aid and advice to many people endeavoring to develop underground waters in northern Washoe County, particularly in Hualipi and Duck Flat Valleys.¹ Mr. Case named 61 valleys which were traversed by Mr. McFarland in making his preliminary survey of underground water conditions.

Chapter 111

During the 1915 legislative session Chapter 111 was enacted, the terms of which augmented the provisions of Chapter 13, Statutes of 1913, which gave the county commissioners of each of the several counties the right to acquire real estate favorably situated for the prospecting for water with the cost to be borne by the counties. The 1915 act eased the cost burden to the counties by the State refunding the cost of the wells to each county that took advantage of the 1913 act.

Chapter 111 provided that when any county of the State had expended in any 1 year for the purposes set forth in the 1913 act (Chapter 13) a sum amounting to \$4,000 or more, upon the filing in the Office of State Controller a certificate to that effect, the state controller would draw a warrant for that amount, but not to exceed \$5,000. As often as any county of the State shall, from year to year, make a similar expenditure upon a like certificate from the county auditor, the state controller was authorized and directed to draw a like warrant upon the State treasury. It was also provided that the sums received from the State were to be set apart in a special fund, and to be used for the purposes mentioned in the act.

Although this act and the 1913 act (Chapter 13) were not repealed until 1957 (Chapter 383), it is not known to what extent, if any, the various counties took advantage of the provisions therein.

Chapter 210

Another act providing for the conservation of underground waters was approved March 24, 1915. This act added a new element to the water law applying to underground water. Section 1 of Chapter 210, Statutes of 1915, reads as follows:

SECTION 1. All underground waters, save and except percolating water, the course and boundaries of which are incapable of determination, are hereby declared to be subject to appropriation under the laws of the state relating to the appropriation and use of water. [Emphasis added].

Sections 2 and 3 of the act were similar to Sections 1 and 2 of the 1913 act (Chapter 54). Both sections of the two acts refer to artesian water and seem to apply to free-flowing wells.

¹ Early in 1929 the author became well acquainted with Mr. McFarland, who was the owner of the Indian Springs Ranch, about 45 miles north of Las Vegas, and at that time was engaged in developing a pecan orchard.

Provisions of the act provide that anyone sinking an artesian well must provide a proper and sufficient casing so as to prevent caving and leakage of water through intervening stratum and must provide necessary valves to control the flow of water from such well, and no person controlling an artesian well shall allow the water to flow to waste. Another provision states that when a complaint is made to the district attorney of the county where an artesian well is situated and when the owner of such well is not complying with the provisions of the act, the district attorney must investigate. If the district attorney finds that any of the provisions of this act are being violated, he must commence criminal action.

It is to be noted that the enforcement of the provisions of this act rested with the district attorney and not the State Engineer. This act, together with the 1935 and 1937 amendments thereto, were not repealed until the Underground Water Act (Chapter 178, Statutes of 1939) was approved.

1935

Chapter 184

Twenty years following the enactment of the 1915 act relating to the conservation of underground water, an amendment was added. This was contained in Chapter 184 and was approved April 1, 1935.

The main amendment to the 1915 act was to place the administration of the provisions of such act in the hands of the State Engineer. Other amendments gave the State Engineer a number of responsibilities. In brief, the State Engineer should designate administrative underground areas and subareas; may require periodic reports of water elevations, water used, and acreage where water was used; should find as to whether there was unappropriated water in the area affected, to issue permit only if such finding was affirmative; may hold hearings on his own motion or upon petition of water users in the area to determine whether the water supply was adequate for the needs of permittees and vested right claimants, and if the finding was negative to restrict the withdrawals in order of priority.

1937

Chapter 149

The 1937 legislation added other amendments to Chapter 210 of the 1915 act and Chapter 184 of the 1935 act. One of the major amendments added was that:

"Every person desiring to sink and bore an artesian well in any proven artesian basin in the state shall first secure from the state engineer a permit to appropriate water. . . ." [Emphasis added].

Other amendments were: the permittee must keep a log of the well, showing type of casing, flow from well or static head of the water in the well (such log must be prepared on forms furnished by the State Engineer). An amendment to the 1935 act, which provided that the State Engineer designate administrative underground areas and subareas, was deleted. It was also provided that the State Engineer was empowered to make such reasonable rules and regulations as might be necessary for the proper and orderly execution of the power conferred by this act.

1939

Chapter 178

The events leading up to the enactment of the 1939 Underground Water Act are related later in this report. As these writings are concerned with the struggle of the early pioneers in working out ways to promote, develop, and utilize the water resources of the State, the author has not attempted to outline the provisions of the underground water law as it now exists.

Chapter 178 was approved March 25, 1939, and with many subsequent amendments and additions, is now one of the most comprehensive ground-water laws in the western states. Briefly, it places in one category all water beneath the surface of the ground that is susceptible of management and it subjects the water to appropriation under the laws of the State only by application to the Office of State Engineer for a permit to appropriate. The only exemption is the use of water from a well for domestic purposes where such use does not exceed 2 gallons per minute.

The legislative acts, pertaining specifically to ground water and leading up to the 1939 ground-water law, emphasized free-flowing artesian wells. The 1939 Underground Water Act provided a number of definitions relating to ground water. Two of the definitions follow: "artesian well" means a well tapping an aquifer underlying an impervious material in which the static water level in the well stands above where it is first encountered in the aquifer; and an "aquifer" means a geological formation or structure that transmits water.

Discussion

The 1903 act (Chapter 4), establishing the Office of State Engineer, stated "All natural water courses and natural lakes, and the waters thereof which are not held in private ownership, belong to the public, and are subject to appropriation for a beneficial use. . . ." The 1905 amendment to the 1903 Irrigation Law (Chapter 46) provided a method for all future appropriations of water, which was left out of the 1903 act. In both of these acts, the legislature was silent as to the appropriation of underground water.

The 1913 General Water Law (Chapter 140) for the first time takes cognizance of underground water as being the property of the public and subject to appropriation under the laws of the State.

During the following legislature session (1915), and as heretofore noted, a law was enacted (Chapter 210) excepting "percolating water, the course and boundaries of which are incapable of determination" from the provision of the general water law relating to the appropriation for beneficial use.

State Engineer George W. Malone in his 1932-34 Biennial Report commented on this exception in the following manner:

"The Nevada Legislature in 1915 passed a law for the conservation of underground water relating wholly to the regulation of artesian flows, . . . , but section 1 of the Act, without apparent connection, would at first glance seem to modify the fundamental water law of the State which declares all water subject to appropriation both above and below the ground

"The above statute is confusing when interpreted literally for the reason that practically all underground water is 'percolating water.'"

Mr. Malone then went on to state,

"Percolation is defined as passing through fine interstices, to filter, etc., and its synonym or parallel expression is given as filter, drain, etc., which almost exactly describes the source of water for our many springs, water holes and wells over the entire State used principally for stockwatering, mining and domestic purposes, and over which the water law, the 1925 stockwater Act and the courts have recognized State jurisdiction by providing methods of appropriation of such water. In fact appropriation and beneficial use of any known water supply, whether natural watercourse or springs developed by tunnel and gravity supply, or by pumping from wells, have been and is recognized by this office and by courts as the fixed policy of the State in the interest of orderly development."

In summarizing the position of the State relative to underground water, Mr. Malone stated as follows:

"It would appear then, in view of this well-developed and established policy, that any interpretation that may subsequently be made will without doubt support the ownership and control by the State of all water put to beneficial use, allowing the individual to control the amount of such water beneficially used subject to priority of use in the regular manner."

Under the 1925 Stock Watering Act (Chapter 201), previously mentioned by State Engineer Malone, the use of water for watering livestock was declared a beneficial use. This act was designed to give the stockman some degree of protection in his grazing rights by acquiring a water right for his livestock under the appropriation laws of the State. In other words, if a stockman developed a shallow or deep well, a water hole, or a spring for livestock use and if no other sources of water had previously been appropriated nearby, the stockman could file an application to appropriate such water. If there were no conflict with other users, the State Engineer could grant a permit to use such water. This act gave the stockman a degree of protection for the grazing of his livestock within a 3-mile radius of such water source.

This brought about a number of applications to appropriate water for livestock use during the late 1920's and 1930's and prior to the advent of the U.S. Bureau of Land Management in 1949. In fact, where the Bureau of Land Management adjudicated the range rights, it took into consideration the existing stock-watering appropriations.

Early Recognition of Underground Water

On August 18, 1894, Congress enacted what was commonly known as the Carey Act. The purpose of this act was to enable the western states to develop their arable lands that were beyond the ability of the individual farmer to develop.

The Carey Act never really got under way in Nevada until 1909, and by that time artesian wells had been drilled in Las Vegas, Pahrump, and other valleys in Nevada. These areas appealed to promoters as an untapped source of water for a Carey Act promotion. Consequently, six Carey Act applications were filed in Las Vegas Valley during 1909-10 with a land segregation of 32,000 acres. Applications also were filed in Pahrump, Amargosa, and other valleys. At that time, the 1907 general water act (Chapter 18) applied only to the appropriation of surface water. However, in conformity with acts of Congress, the state land register (surveyor general) had to enforce certain requirements, one being that the project was feasible; another, that sufficient water existed for the project; and lastly, that the proposer had acquired title to the water.

This in turn led to State legislation, approved March 17, 1911, that took note of underground water by making it subject to appropriation to comply with the provisions set forth by Congress. Shortly thereafter, State Engineer William M. Kearney developed detailed regulations as to the appropriation of underground water under the provisions of the 1907 water law. Thus, 2 years prior to the adoption of the 1913 General Water Law (Chapter 140, Statutes of 1913), wherein underground water was declared to be the property of the State and subject to the laws relating to appropriation, applications were being accepted by the State Engineer to appropriate ground water under the provision of the Carey Act.

Although the Carey Act was expected to be a major milepost in western reclamation by irrigation, it generally proved to be a failure. Only one project was completed in Nevada; it is related more fully in appendix 3.

Applications to Appropriate Underground Water

The passage of the 1913 General Water Law, which provided that the waters of all sources, whether above or below the surface of the ground, and the 1915 (Chapter 210) act, providing for the conservation of underground water, had little effect on the then owners of wells and owners of new wells being drilled in the matter of filing an application to appropriate as provided by law. This is borne out by the records of the State Engineers in their biennial reports. For instance, the records from 1905 through 1918 indicate that 5,345 applications to appropriate water had been filed, and of this number only 109 were to appropriate ground water.

Table 2 presents the trend in the filing of applications to appropriate ground water as against the total number of applications filed with the State Engineer. The author made no attempt to follow up on the ultimate outcome of these applications, but from personal experience knows that a great number of them were never completed, either by being withdrawn, denied, or cancelled for failure to comply with the provisions of the permits.

TABLE 2.--*The trend in the filing of applications as between surface water and ground water, 1905-55*

Year	Total number of applications filed ¹	Ground-water applications					
		Number filed	Percentage of total applications filed	Intended use of the water			
				Irrigation	Stock	Mining, milling	Other
1905-18	5,345	109	2	58	28	18	5
1919	581	24	4	15	5	4	0
1920	439	27	6	17	5	4	1
1930	202	50	25	13	30	5	2
1935	100	26	26	5	7	12	2
1940	145	59	41	30	3	15	11
1944	183	105	58	53	25	3	24
1950	365	207	57	100	62	7	38
1955	890	757	85	640	7	10	100

¹ Surface-water applications plus ground-water applications.

DEVELOPMENT OF NEVADA'S WATER RESOURCES AS CHRONICLED IN THE STATE ENGINEERS' BIENNIAL REPORTS

This treatise is generally concerned with the evolution of the water laws of Nevada. Nonetheless, many other important water-related programs are discussed herein to aid the reader in understanding the broad scope of the work involved and the importance of the Office of State Engineer.

This section points out the important part exercised by the U.S. Geological Survey in evaluating the water resources of Nevada since the turn of the century. From 1900 to about 1938 the work of the Survey consisted primarily of carrying on a stream-measurement program. Starting at the latter date, a comprehensive ground-water program was inaugurated. Both of these cooperative programs are still being effectively carried on with the Federal Government and the State of Nevada sharing the funding on a 50-50 matching basis.

It should be noted that other Federal and State agencies have greatly contributed toward the development of the water and land resources of Nevada. For instance, one of the major reasons for the creation of the Office of State Engineer in 1903 was to put the State in a position to assist the U.S. Reclamation Service in the development of the Truckee-Carson Reclamation Project involving the waters of the Truckee and Carson Rivers. Other important cooperators were the U.S. Department of Agriculture, U.S. Soil Conservation Service, U.S. Army Corps of Engineers, U.S. Bureau of Land Management, U.S. Bureau of Indian Affairs, U.S. Forest Service, and the University of Nevada Agricultural Experiment Station.

As mentioned earlier, the biennial reports of the State Engineer represent the most complete history of the activities involving the work of the Office of State Engineer. Accordingly, activities of the Office of State Engineer and several cooperative programs presented in the following pages, are taken from biennial reports of the State Engineer.

1903-04

Mr. A.E. Chandler, Nevada's first State Engineer, was appointed by Governor John Sparks on May 29, 1903, pursuant to the 1903 Irrigation Law (Chapter 46). Mr. Chandler served as State Engineer from May 29, 1903, to May 1, 1905, then accepted the position as engineer of land and legal matters in the field for the U.S. Reclamation Service. In his biennial report submitted December 31, 1904, he paid tribute to L.H. Taylor, Supervising Engineer in charge of the U.S. Reclamation Service, in furthering the work of his office.

Mr. Chandler noted that the most important work of the Office of State Engineer was the determination of the priority of water rights on the Carson River. This was, of course, so the development of the Truckee-Carson Reclamation Project could proceed without delays because of the lack of information as to water rights on the Carson River.

It is of interest to note the first major canal system surveyed by the U.S. Reclamation Service in Nevada was to supply water to Lemmon Valley and other valleys north of Reno. It was to be known as the Truckee River High-Line Canal, designed to supply water to 73,000 acres of land in the several valleys north of Reno. The diversion point from the Truckee River was to be at Floristan, Calif., the canal to run northerly 31 miles. This plan was abandoned, because of the cost involved, in favor of the Truckee-Carson Canal that was constructed as part of the Truckee-Carson Reclamation Project.

Mr. Chandler noted the stream-measurement program of the U.S. Geological Survey in Nevada began in 1889. During 1903 and 1904, regular stream-gaging stations were monitored on the main rivers of Nevada and their tributaries.

Mr. Chandler made several suggestions as to needed legislation, one was to amend the 1903 Irrigation Law to provide control of all new appropriations by the State Engineer. He also cited some of the problems confronting the State irrigation engineers of the western states:

"The following eight states now have State Irrigation Engineers: Colorado, Idaho, Montana, Nebraska, Nevada, North Dakota, Utah, and Wyoming. Realizing that they have many interests in common, and that much good would result from regular meetings, these engineers formed the Association of State Engineers at Salt Lake City in May, 1904. The first regular meeting was held at Boise City, Idaho, in September, 1904. At this meeting all of the eight States, with the exception of Colorado and North Dakota, were represented, and the following resolutions were unanimously adopted:"

These resolutions, in brief, were as follows:

- "1. That it is the sense of this Association that the various States have the authority to regulate the diversion, appropriation and use . . .
- "2. That . . . rights to the use of water should be limited to a definite volume for each season rather than to a definite flow for an indefinite period, . . .
- "3. That . . . the State Engineer should have discretionary powers in the approval of applications for new appropriations . . .
- "4. That . . . the maps accompanying applications for permits should be drawn from actual surveys . . .
- "5. That . . . all water rights should be appurtenant to the land irrigated and inseparable therefrom except through a regular legal procedure . . .
- "6. That . . . the State Engineer should be made the responsible executive of the administration of water rights . . ."

State Engineer Chandler then went on to write:

"There are three main features involved in all of the better codes: First, the control of all new appropriations by the State Engineer; second, a direct and inexpensive method for the determination of existing rights; and, third, provision for the division of the streamflow according to priorities in time of scarcity.

"The law passed in Nevada in 1903 possesses the last two features, but the first is absent, and new appropriations are still governed by the original law of 1866." [Emphasis added]

This 1866 law, as previously outlined, was contained in Chapter 100, Statutes of 1866. Briefly, as stated by Mr. Chandler, it provided that any person desiring to construct a ditch should file with the county recorder of the county or counties in which proposed ditch is to be located, a certificate, previously sworn to, and specify the name of the ditch and the location of its termini. In this way, the ditch filings were scattered throughout the several counties of the State. In order to determine what recent filings had been made on a stream, an examination must be made of the records of every county through which the stream flowed. But, after the records had been found, there was nothing to show whether the ditch had been constructed. Such records were of doubtful value.

From the 1903-04 Biennial Report by the State Engineer Chandler, it is evident that several of the western states were ahead of Nevada in the control and administration of the water resources of the State. Therefore, in presenting the 1903 Irrigation Law to the legislature, the report contained proposals for needed legislation that had already been adopted in other western states.

1905-06

Governor John Sparks appointed Mr. Henry Thurtell as the second State Engineer of Nevada on May 1, 1905, to fill out the term of A.E. Chandler. Mr. Thurtell's term of office extended to May 1, 1907, when he resigned to accept a position as railroad commissioner of Nevada, having served a period of 2 years.

The work of the State Engineer, as described by State Engineer Henry Thurtell in his 1905-06 Biennial Report, consisted primarily in carrying out the provisions set forth in the Irrigation Law of 1903 pertaining to the determination of the priority of water rights. During this period, the determination of water rights on the Carson River had been made and 376 certificates of water rights had been issued. The claims to water rights on the Muddy River had been assembled and the work of collecting proofs of appropriation on the Humboldt and Walker Rivers had commenced.

During Mr. Thurtell's term of office the major work entailed the determination of water rights, primarily on the Carson River. In describing this work, Mr. Thurtell told it this way:

"Irrigation began upon the Carson River in the early fifties, and the tracing out the history of the use of water on the various parcels of land in that valley has been a work of more than usual difficulty. That this has been done with at least reasonable care and fidelity seems to be evidenced by the fact that not one of the one hundred and fifty users of water have up to this time taken an appeal from the decision of the State Engineer."

On the basis of this listing of priorities for water on the Carson River, the Board of Irrigation passed a resolution that it could appoint commissioners on the Carson River in each of the Water Districts if requested to do so by a petition signed by five or more water users. The board divided the territory watered by the Carson River into the following four Water Districts:

- Water District No. 1--Land watered by the East Carson River in Douglas County.
- Water District No. 2--Land watered by the West Carson River in Douglas County.
- Water District No. 3--Land watered by the Carson River in Ormsby County.
- Water District No. 4--Land watered by the Carson River in Lyon County.

Mr. William Daughery and Mr. George Springmeyer acted as commissioners of Water District No. 1, Mr. Wallace Park as commissioner of Water District No. 2, and Mr. Sam Stevenson in Water District No. 4. No commissioner was appointed for district number three. No water commissioners were appointed in 1906 because it was a wet year and an ample supply of water was available.

Mr. Thurtell outlined the surveys being made on the Muddy, Humboldt, and Walker Rivers. In discussing the Walker River, he wrote:

"It seems absolutely certain that the construction of a storage reservoir on the Walker River by Government aid will not proceed until the rights of each farmer in and to the natural flow of the water of the river has been determined. It seems equally certain that it will be impossible for any collection of farmers representing any large proportion of the real users of the water to get together a plan for construction and an equitable sharing of uses and profits from storage without first having an actual determination and definition of their rights."

As suggested by former State Engineer A.E. Chandler, the 1905 legislature amended the 1903 Irrigation Law by prescribing a method of securing new appropriations of water through application to the State Engineer. Under the new amendment, 31 applications were filed during the calendar year 1905 and 291 during 1906. Most of these applications were for mining purposes.

The gaging of streams was continuous during 1905 and 1906. During 1906, measurements were made by Mr. Leland Sparks of the U.S. Geological Survey upon all the creeks tributary to the Truckee River during the season of excessive flow in May and June.

1907-08

Governor John Sparks appointed Frank R. Nicholas on May 1, 1907, as the third State Engineer for Nevada. This was at the beginning of Governor Sparks second term.

During the 1907-08 years, the work load of the office had greatly increased. The Board of Irrigation, consisting of the Governor, surveyor general, attorney general, and State Engineer, was given additional power to appoint water commissioners and make rules and regulations for the proper administration of the waters of streams such as the Carson and Muddy Rivers.

During 1907-08, a total of 908 applications was filed to appropriate water, making the total 1,170 since the 1905 amendment took effect. The work of investigation of these applications placed a heavy burden on the limited staff of the Office of the State Engineer. In commenting on the work involved, Mr. Nicholas wrote:

"It has been found by experience that documentary evidence addressed is often misleading and exaggerated, and that true conditions cannot be determined without a personal investigation of the proposed diversion and use."

The work of adjudication of the priorities of water rights on the Humboldt, Truckee, and Virgin Rivers was proceeding as rapidly as possible with a limited staff.

In his 1907-08 Biennial Report, Mr. Nicholas stated that the Truckee-Carson Reclamation Project had reclaimed an area of 100,000 acres of arid land situated in the Carson Basin, and at that time water rights had been sold for approximately 40,000 acres.

In cooperation with the U.S. Geological Survey, stream-gaging stations were established on the Truckee, Carson, and Walker Rivers, and within the Humboldt River basin. This cooperative program continued until June 30, 1908, when lack of State funds forced its suspension until 1913 when matching State funds again became available.

During the early years, the Nevada State Legislature gave the State Engineer other duties to perform entirely apart from his established duties pertaining to the water resources of the State. State Engineer Nicholas described one such project for the development and enlargement of the water supply for the State buildings in Carson City. It entailed the construction of a concrete reservoir, 100 feet long, 50 feet wide, and 10 feet deep. In addition, a smaller reservoir was constructed in Vicee Canyon. In connection with this project, the State Engineer supervised the laying of 5,000 feet of 8-inch "Converse" lock-joint pipe from Vicee Canyon toward Carson City.

1909-10

Governor John Sparks died in office May 22, 1908, and was succeeded by Lieutenant Governor Denver S. Dickerson to fill out the unexpired term to the end of 1910. Tasker L. Oddie became Governor on January 1, 1911.

Frank R. Nicholas continued to serve as State Engineer the first year of this biennial period (Jan. 1, 1909 to March 2, 1910), and upon his resignation Acting Governor Dickerson appointed Emmet D. Boyle ¹ for the balance of the 2-year period covered in the 1909-10 Biennial Report (March 8, 1910 to March 23, 1911).

The biennial report for this period was written by Mr. Boyle. He noted the adjudication of vested rights to the use of water from the Carson River was begun by State Engineer A.E. Chandler, who had completed his determination of priorities on the East and West Forks. There remained the adjudication of water rights downstream from Churchill Canyon and in Carson Sink.

Mr. Boyle described the Truckee-Carson project in some detail, stating that the construction of Lahontan Reservoir on the Carson River was getting under way.

During this biennial period, 683 applications had been filed to appropriate water. In addition to the office and field work involved in processing these applications and evaluation of unacted-upon applications from previous years, the work of adjudicating the water rights on the Truckee, Humboldt, and Quinn Rivers was proceeding as rapidly as possible.

¹ Emmet Boyle became the 14th Governor of Nevada, having been elected on November 3, 1914, and again November 8, 1918.

Carey Act Projects

Mention has been made of this Federal-State program which originated in the Congress in 1894. The results of the Carey Act program in Nevada are shown in some detail in appendix 3; no further mention is made of the program here, other than to say that it enlarged the work of State Engineer and the state land register (surveyor general) to a considerable extent during the 1909-20 period.

Incidental Duties--Construction Work

The Office of State Engineer, in accordance with action by the 1909 Nevada State Legislature and at the request of the various Boards in control of State institutions, acted on a number of matters. One such task was to prepare specifications for an 8-inch "Converse" lock-joint pipe to replace part of the original line of 4-inch black pipe for the State-owned water system in Carson City.

Another project consisted of the completion of a power plant and pumping station at the Hospital for Mental Diseases in Reno. The State Engineer prepared the specifications. During the 1907-08 period, the State Engineer designed the power plant and water wheel to utilize the State-owned water rights on the Sullivan ditch. During 1909, the power plant was improved by the installation of a 2,500-volt belt-driven generator and other necessary additions, so arranged that when the water supply owned by the State proved insufficient, the hospital circuits could be connected with the power provided by the Reno Power, Light and Water Company. The plant, when completed, was giving excellent service.

Another project, delegated by the Nevada State Legislature, was to prepare plans and be superintendent and architect for a new Nevada State Penitentiary. The State Legislature directed State Engineer Nicholas to examine a number of modern prisons in various states, be superintendent and architect of the new penitentiary, and submit a report to the Board of Prison Commissioners. Several proposals were submitted on May 9, 1910, immediately after Mr. Boyle had become State Engineer on March 8, 1910. Before the final plans were approved, Mr. Boyle reported he was in disagreement with the Board of Prison Commissioners.

A Suggested Water Law

State Engineer Boyle noted the irrigation code of Nevada had developed certain weaknesses. A new code was prepared after consultation with other water experts, including former State Engineers A.E. Chandler and Henry Thurtell.

During the legislative session of 1909, Chapter 164 provided guidelines for the State Engineer in acting on Carey Act projects. One such rule provided the developer must have a permit to appropriate water for the project. During 1909, several Carey Act projects were proposed that were to use underground water as a source of supply, mostly within the Las Vegas Basin.

Although the State water law made no reference to underground water at that time, it seems likely that State Engineer Boyle thought he had made proper provisions for appropriation of ground water in Section 1 of the proposed water law, which reads as follows:

SECTION 1. All water within the limits of the State from all sources of water supply belong to the public and are subject to appropriation for beneficial use.

All such waters not heretofore appropriated may be appropriated as provided in this Act, and not otherwise.

State Water Right Surveyors

Another provision included in the suggested law provided for the appointment of State water right surveyors. Mr. Boyle felt that in the matter of preparing maps to support applications to appropriate water and the preparation of proofs required by the State Engineer, licensed State water right surveyors would be of great assistance in carrying out the duties of his office. Unfortunately, such a provision was not included in the water law until 1921 (Chapter 106). Although the Nevada State Legislature failed to approve Boyle's proposed water law, it nevertheless contained many provisions later included in the 1913 General Water Law.

Protested Applications

In the matter of approving applications to appropriate water which were protested, State Engineer Boyle set forth the quandary that has faced all State Engineers in the following well-expressed language:

"The protests against the granting of applications for permits to make new appropriations give eloquent expression of the constant fear of fatal invasion of older rights by new appropriations, and until all rights from important streams are determined and defined, this department will continue to stand between the Scylla of injunction by downstream appropriators when permits to appropriate water above them are issued and the Charybdis of stagnated irrigation development should a policy of rejecting applications for new rights be adopted."¹

Recommendations

Mr. Boyle stated that the State should cooperate with the U.S. Geological Survey in the gaging of streams on a cooperative financial basis whereby that Federal agency expends a sum of money annually in each State equal to whatever sum the State may appropriate for the work.

Another recommendation suggested that a general reconnaissance of the various sources of supply within boundaries of the State for the purpose of obtaining general data as to the amount of water available for use, over and above present appropriations, should be made at once. The reconnaissance was to include some practical determinations of area where it seemed large subterranean sources of supply might be encountered.

¹ "Scylla" is a rock opposite the whirlpool "Charybdis" off the coast of Sicily (an island south of Italy). The expression means "between two dangers." Webster's Student Dictionary.

1911-12

William M. Kearney¹, Nevada's fifth State Engineer, was appointed by the newly elected Governor, Tasker L. Oddie, on March 21, 1911. He served as State Engineer during Governor Oddie's term of office and was reappointed by Governor Emmet D. Boyle. Mr. Kearney resigned on May 15, 1917, after serving 6 years.

The Biennial Report of 1911-12 indicated a rapid expansion of the work of the State Engineer. This report contains a great amount of historical data and outlines in some detail the work accomplished.

The adjudication of vested water rights on a number of rivers was described, including the Humboldt, Little Humboldt, White River, and a number of small stream systems. He noted that the waters of Carson River had been regulated for 8 years.

A section of the report was devoted to the development of irrigation projects. The Truckee-Carson Reclamation Project was discussed in great detail. Another Carey Act project was described as the dam being constructed by the Pacific Reclamation Company on Bishop Creek, in Elko County.

Irrigation Investigations

A report of irrigation investigations authorized by the 1911 Nevada State Legislature (Chapter 141) was given. The records of stream discharge at various locations along the Humboldt River for 1912 were listed. Also listed were the results of water-evaporation studies near Lovelock, Winnemucca, and Reno.

Las Vegas Underground Water Resources

For the first time since creation of the Office of State Engineer in 1903, attention was called to the water resources lying beneath the surface of the ground. Up to 1912 little attention was given to ground-water resources, no doubt because they gave the State Engineer little concern, other than the use of such water resources for Carey Act projects.

Mr. Kearney, realizing the potential of ground water in the Las Vegas Valley, started an investigation during 1912. He reported:

"The prominence of the artesian belt in the Las Vegas Valley caused the State Engineer to attempt to determine the general limits in which one might expect to find water by additional borings.

"The large number of wells already demonstrated on the surface, and unsuccessful borings, served as a basis for the preparation of a map from which might be determined the direction of the underground flow, if such existed, and the probable limits of the belt.

¹ William M. Kearney was a graduate engineer from the University of Nevada. During his term as State Engineer, and perhaps even before, he studied law. In 1914, while still State Engineer, he was admitted, by way of examination before the State Supreme Court, to practice law in Nevada. During the late 1930's and 1940's, the author held many hearings at which Mr. Kearney was one of the lawyers involved. Mr. Kearney was recognized as one of the leading attorneys on water and mining laws in Nevada and the West.

"Before a map could be compiled it was necessary to obtain data from each of the owners of existing wells. Mr. J.T. McWilliams tendered his services to the State and obtained from the majority of well-owners the required data." ¹

This was, no doubt, the first detailed tabulation of existing wells in Las Vegas Valley up to 1912. Some 95 wells were listed, giving the owner's name, the legal description, depth, and on the flowing wells, the height of the flow above the top of the casing.

A U.S. Geological Survey report stated that in the summer of 1912 about 125 wells were sunk in the valley fill. ²

In his 1911-12 Biennial Report, Mr. Kearney recommended the cooperative stream-measurement program with the U.S. Geological Survey be reactivated. He also recommended the legislature provide funds for irrigation investigations in cooperation with U.S. Department of Agriculture.

1913-14

The 1913 General Water Law was enacted by the Nevada State Legislature on March 22, 1913 (Chapter 140). The constitutionality of this act was attacked, particularly that part of the act applying to the adjudication procedure. During this period, and for some time following, a number of law suits were filed involving the State Engineer and constitutionality of the 1913 water law and later amendments.

Mr. Kearney noted that a systematic measurement of flow of the main Humboldt River and important tributaries had been made by the U.S. Geological Survey in cooperation with the Office of State Engineer, under active charge of Mr. E.A. Porter, District Engineer, U.S. Geological Survey.

Mention was made of the experimental work, under a cooperative arrangement with the U.S. Department of Agriculture and the University of Nevada Agricultural Experiment Station, regarding the quantity of water needed to irrigate different crops grown in various valleys of the State, seepage loss in ditches, and evaporation losses.

The Carey Act proposals became less frequent and only three applications for temporary withdrawals of land were made during the biennium.

¹ J.T. McWilliams was one of the early pioneers in the Las Vegas Valley. He became the county surveyor and served as such for some time. Shortly after arriving in Las Vegas he purchased a tract of land west of the railroad and laid out a townsite, known as "West Side" or sometimes "Old Town." When the author arrived in Las Vegas in January 1929, he set up a surveyor's office next to "Mac's" office in the Mesquite Building. For about 3 years, the author did a great amount of the field and office work for Mr. McWilliams, who, along with Mrs. McWilliams, aided the author in many ways.

² Carpenter, Everett, 1915, Ground water in southeastern Nevada: U.S. Geological Survey Water-Supply Paper 365, 86 p.

During the biennium, 628 applications were filed to appropriate water. To demonstrate the amount of work involved in processing applications, Mr. Kearney listed the details of about 255 field examinations that had been made. Mr. Kearney noted that prior to the 1907 law no fee was required for filing an application to appropriate, which, no doubt, was responsible for so many applications being filed. The law of 1907 set a fee of \$25 for such filing.

1915-16

The number of applications to appropriate water increased greatly during this period, there being 1,043 filed of which 526 were approved, 31 denied, 66 canceled, 35 withdrawn, and 385 not acted on.

The cooperative streamflow-measurement program with the U.S. Geological Survey was resumed, the legislature appropriating \$5,000, which was matched by an equal amount by the Federal agency, for the biennium. Some 34 streamflow-measurement stations were maintained.

State Engineer Kearney described in some detail the work of irrigation investigations carried on cooperatively by the U.S. Department of Agriculture and the Nevada State Agricultural Experiment Station. The work involved a number of weirs to be installed under the direction of Mr. James G. Scrugham¹, in charge of the Department of Engineering Experimentation at the University of Nevada.

During 1916, Mr. F.L. Bixby, Irrigation Engineer for the U.S. Department of Agriculture, was in charge of the work. Mr. Kearney summarized the irrigated lands in the State as follows:

Rights initiated prior to creation of Office of State Engineer	802,700 acres
Acres included in certificates issued by the Office of State Engineer	9,560
Percentage (acreage) of land irrigated under incomplete permits	<u>34,000</u>
Grand total	846,260 acres

1917-18

On May 15, 1917, William M. Kearney, who had been State Engineer since March 21, 1911, resigned. Governor Emmet D. Boyle appointed James G. Scrugham as State Engineer on May 16, 1917. Both Mr. Scrugham and Assistant State Engineer B.G. McBride resigned January 10, 1918, to accept commissions in the Ordinance Department of the Army. Seymour Case, who had been acting as Deputy State Engineer, was appointed on January 22, 1918, to fill out Mr. Scrugham's term. The 1917-18 Biennial Report was submitted to Governor Boyle by Seymour Case.

¹ James G. Scrugham became State Engineer in 1917 and again in 1919 after his service in the U.S. Army. In 1922, he was elected Governor for one term; he served as the lone U.S. Representative to Congress from Nevada from 1933 to 1943, and as U.S. Senator from 1943 until his death June 23, 1945.

Mr. Case outlined the cooperative irrigations investigation that had been continued from the previous biennium between the State Engineer and the Irrigation Division of the Federal Bureau of Public roads under direction of F.L. Bixby, Senior Irrigation Engineer with the Federal Bureau of Public Roads. The work of the cooperative stream-measurement program under leadership of A.B. Purton, District Engineer, U.S. Geological Survey, at Salt Lake City, Utah, was continued.

During the 1917 session of the legislature, the sum of \$5,000 was added to the budget of the State Engineer to carry on investigations pertaining to underground waters of the State. State Engineer Scrugham secured the services of Ira MacFarland to carry on this investigation. During the summer of 1917, Mr. MacFarland investigated 61 basins in this preliminary examination and reported thereon.

1919-20

James G. Scrugham was again appointed State Engineer on March 28, 1919, following his return from Army service and served to October 7, 1922. He was appointed by Governor Emmet D. Boyle at the beginning of his second term as Governor.

In addition to day by day work of the Office of State Engineer a number of new activities were set forth in this biennial report to the Governor by Mr. Scrugham.

Colorado River

For the first time, the potential of the proposed Boulder Dam on the Colorado River was noted, and at the request of the State Engineer, a commission of citizens was appointed by the Governor to be responsible for the interests of Nevada.

Ground Water

A long article on ground water by State Engineer Scrugham was set forth describing the potential of this water resource. The article clearly indicated that he was knowledgeable as to the occurrence of ground water, the engineering principles involved, as well as the value of this source of water. In part he wrote:

"Practically all of the normal flow of the surface streams of the State is appropriated, either under old vested rights, or by permits from the State Engineer's Office. Irrigation of new lands must be largely secured either from waters impounded during the flood seasons or from supplies of underground waters.

"The development of ground waters in Nevada has been greatly hampered by a lack of knowledge of what conditions were essential for economic success."

Mr. Scrugham went on to describe how ground water occurred and accumulated in the valley-fill sediments from precipitation falling on higher elevations. He noted some 21 valleys that contained the elements necessary for agricultural development, namely: adequate topography, watershed, soil, climate, and accessibility.

Stock-Watering Rights

State Engineer Scrugham noted several hundred applications for permits to use excess water from small sources were pending upon which stock-watering rights existed. Many of the applications mentioned were from stockmen who desired to get a foothold on public rangeland now used by other persons. Action on these applications was to be withheld pending the formulation of a better rangeland policy by the Federal and State Governments.

Stream-Measurement Programs

The cooperative streamflow-measurement program for this biennium remained about the same as for the last period. Twenty-eight streamflow-measurement stations were being maintained, including two stations each for the U.S. Bureau of Indian Affairs and U.S. Bureau of Reclamation.

Irrigation Investigation

Irrigation investigations on the Humboldt River by the U.S. Reclamation Service, in cooperation with the State of Nevada, was carried on with a State appropriation of \$4,000. The possibilities of irrigation development on Humboldt River were studied. The report cited the importance of reservoir sites that should be developed. In order of priority, the report concluded that the Humboldt-Lovelock, South Fork, North Fork, and Oreana dams should be constructed.

Cooperative Snow Surveys

This program was, for the first time, inaugurated in 1919 by informal agreement between the States of Nevada and California in an attempt to give practical application to the plan of snow surveying and forecasting of streamflow, which had been developed by the Nevada Agricultural Experiment Station. The Nevada appropriation for the biennium was only \$1,500.

Dr. J.E. Church, Jr., of the University of Nevada had been given world-wide recognition for pioneering this scientific work. Snow surveys rapidly proved their worth, and the program spread to practically all western states, Canada, and other foreign countries. Here in the West, snow surveys have become the major tool used by the U.S. Soil Conservation Service in determining spring and summer runoff.

1921-22

State Engineer James G. Scrugham resigned his office October 7, 1922, to commence his election campaign for governorship. Mr. Robert A. Allen, who had been Assistant State Engineer, was appointed by Governor Boyle on October 7, 1922, to complete Mr. Scrugham's term. Mr. Allen was again appointed State Engineer by Governor James Scrugham, who was elected and began his term in January 1923. Mr. Allen continued to serve to March 28, 1928.

During this biennium the legislature created two new commissions, namely the Colorado River Development Commission (this commission became of great importance, with the State Engineer acting as secretary) and the Owyhee River Commission (its period of existence was limited primarily to this biennium).

State Engineer Allen, who no doubt edited the 1921-22 Biennial Report, stated perhaps the major irrigation problem confronting people of Nevada was caused by the development of resources along the Humboldt River system. He noted the importance of vigorously completing the adjudication process, not only on large streams but also on small ones.

State Water Right Surveyors

The water law was further amended by the addition of a new section providing for licensing of engineers as State water right surveyors (Section 1, Chapter 106, Statutes of 1921). As previously mentioned, State Engineer Emmet Boyle in his 1909-10 Biennial Report proposed a new water law, which included a section pertaining to the establishment of State water right surveyors as an aid to the Office of State Engineer in handling preparation of maps to support applications and proofs required under law.

Among the recommendations mentioned was a legislative appropriation of \$2,500 for experimental research to improve water-well development and to assist settlers by giving advice on pumping equipment, testing, and well development. Additional money (\$3,000 annually) was recommended for the cooperative streamflow-measurement program with the U.S. Geological Survey.

Snow Surveys

Dr. J.E. Church, Jr., who originated the snow-surveying technique of measuring the water content in snow packs along the higher elevations of a river drainage basin and thus being able to forecast, with reasonable accuracy, the spring runoff for such a river system, presented a detailed report of the studies to date. He noted the spread of this program in the western states. Professor H.P. Boardman, Dean of the Civil Engineering Department at the University of Nevada, assisted Dr. Church in his research for many years and should be given due credit for his assistance in the snow-survey program. The State Engineer recommended additional financial support from the State.

Colorado River Development Commission

This commission was created under Chapter 115, Statutes of 1921. The members appointed by Governor Boyle were Levi Syphus, C.P. Squires, Edward Clark, and State Engineer James G. Scrugham. All seven states of the Colorado River Basin had formed similar commissions.

The Nevada commission selected James G. Scrugham as chairman and C.P. Squires as secretary. After many formal hearings the commissions finally met in Santa Fe, N.Mex., and drafted a pact. With the authority of an act of Congress, an agreement covering the allotment of water to each of the seven states was to be ratified by the states and the Congress of the United States. The President appointed Herbert Hoover as representative of the United States in the negotiations.

The proposed Colorado River Compact was approved by all seven states on August 19, 1921. However, it was never approved by Congress, and therefore the water and power allotments to the several states were the subject of litigation for many years. The subsequent State Engineers, as secretaries of the commission, were burdened with a heavy work load, especially concerning negotiations as to the power allotment from Hoover (Boulder) Dam.

Owyhee River Commission

The work of this commission, which was created by an act of the legislature in 1921, was to investigate storage possibilities on the South Fork of the Owyhee River in Elko County and the transfer of such stored water by means of a 60-mile canal to the headwater of a tributary of the Little Humboldt River in Humboldt County. Several surveys were made, some as early as 1916, but results were negative, largely because of the lack of water supply and excessive construction costs.

The Owyhee River is a tributary of the Snake River and passes through parts of Idaho and Oregon before reaching the Snake River. Even if the project had been found feasible, it no doubt would have met with great opposition from Idaho and Oregon.

1923-24

State Engineer Allen wrote that the procedure regarding water rights had remained substantially the same during all the years the Office of State Engineer had existed. He noted the water code had been attacked from every conceivable angle, fought through the Federal Court, State District Courts, and State Supreme Court, until a code was formulated that is in all respects constitutional.

Mr. Allen commented on the shortage of water during the biennium. This made it necessary to distribute water on most of the rivers and principal streams in Nevada by priority and beneficial use as adjudicated.

During 1924, the State Engineer distributed water on the Truckee River from the Steamboat Canal head to Wadsworth. Although at this time the Truckee River was under control of the Federal Court, a group of water users asked the State Engineer to distribute water. It was also noted that five large pumping plants had been installed at the outlet of Lake Tahoe during July and August 1924--the average discharge to the Truckee River being about 250 cubic feet per second. The pumps were operated under the direction of the State Engineer.

On the Humboldt River, water was distributed in accordance with the order of determination then before the court for final disposition. The stream discharge of the East and West Forks of the Carson River was less in 1924 than during any previous year of record. Mr. Allen reported the adjudication of the Carson, Little Humboldt, and Pahrangat Rivers, and several minor stream systems was again in progress.

The streamflow-measurement program was described by Mr. A.B. Purton, District Engineer, U.S. Geological Survey. During the biennium, records were obtained at 30 regular stations in addition to a number of miscellaneous sites.

Dr. Church again outlined in some detail the progress being made on the cooperative snow-survey program. In his recommendations, State Engineer Allen made this potent comment:

"The work of the State Engineer's office is so interwoven with stream gaging and snow surveys that it represents a single unit and may be considered as a whole. The amount of water to be available during the irrigation season is forecast by the snow survey, measured in the rivers by the stream-gaging department, and is finally distributed to the users by the State Engineer's office."

1925-26

The extreme drought during this biennium period forced the State Engineer to utilize most of his staff to assist in distribution of water during the irrigation season.

During the fall of 1925, the State Engineer was called upon to act as construction engineer for the Nevada State Penitentiary at Carson City to complete the building program as authorized. State Engineer Emmet Boyle told about the authorization of the prison rebuilding program in the 1909-10 Biennial Report. Also, the State Engineer was called upon to make a study of the sewage disposal problem at the Nevada Hospital for Mental Diseases in Reno.

A.B. Purton, District Engineer, U.S. Geological Survey, in his report on the streamflow-measurement program noted:

"The first systematic attempt to inventory the water resources of Nevada was the establishment in 1888 by the United States Geological Survey of a few gaging stations in connection with special studies relating to irrigation in western states."

Stock Watering Act of 1925

The Stock Watering Act (Chapter 201, Statutes of 1925) was approved by the Nevada State Legislature April 1, 1925. Although the act became law in 1925, it was not declared valid by the Nevada Supreme Court until February 21, 1927.¹ Following the decision upholding the act, applications for stock-watering purposes were received in great numbers. To illustrate the purpose of this act, portions of a statement contained in the 1927-28 Biennial Report are quoted:

"In early days of sparse population the cattlemen experienced little difficulty in matters of range control since there was more than enough range for all. Soon, however, with the advent of new settlers to the State in ever-increasing numbers, the old condition of abundant range gradually gave way to a new order. Encroachment on existing established ranges resulted in their curtailment and contraction to a point where they were no longer sufficient to maintain the herds which had formerly flourished and increased from year to year. . . . The result was a gradual transition from a condition of peaceful possession of sufficient range to one of range chaos and strife sometimes resulting in so-called range wars."

"A solution was finally evolved whereby range control could be indirectly accomplished, in a measure at least, through administration of water resources, over which the State exercised unquestioned control. Thus the stock watering Act of Nevada became a law on April 1, 1925."

¹ In *Re Calvo*, 50 Nev. 125, 1927.

The act, in part, provided as follows:

1. The use of water for watering livestock is a beneficial use and the right to its use may be acquired in the same manner as for any other beneficial use.
2. Whenever a valid stock-watering right exists at a particular place to water livestock and in sufficient numbers to substantially use all the public range accessible to such watering place, no appropriation of water by others should be made.
3. The State Engineer must deny any application under such a subsequent application to appropriate water if he finds the right applied for will conflict with the grazing use of the public range by the owner of a prior water right.

Another important section of the act provided that any person who, without the right to do so, shall on two or more separate days during any season, water more than 50 head of livestock at the watering place at which another shall have a subsisting right to water more than 50 head of stock, or within 3 miles of such place, shall be guilty of a misdemeanor. A number of other provisions were included that are not mentioned here.

To properly act on these applications the State Engineer requested the stockmen voluntarily submit maps showing boundaries of the ranges claimed by them. The stockmen responded, and by 1930, a total of 224 range claimants had submitted maps. Many adjustments of the claimed range boundaries had to be made, based upon later field examinations and hearings. The maps proved most useful to the State Engineer as it enabled him to notify claimants of range rights in the immediate vicinity of a new application. If conflicts existed, one of the engineers from the office would make a field investigation. If the matter could not be solved satisfactorily in the field, a hearing would be held, usually with the litigants being represented by counsel. When the author first entered the Office of State Engineer as a deputy engineer in 1935, he was assigned to handle a great many of the field investigations as well as subsequent hearings.

With the advent of the Taylor Grazing Act in 1934, under the U.S. Department of the Interior, the operation by the State under the Stock Watering Act of 1925 gradually gave way, as the U.S. Grazing Service (in 1946 incorporated into U.S. Bureau of Land Management) exercised its control of grazing of livestock on the public range. However, the range rights, more or less established under the administration of the 1925 Stock Watering Act, were later recognized to a considerable extent by the Bureau of Land Management.

In Retrospect for the Years 1903-26

The preceding pages have presented a generalized resumé of activities carried on by the Office of State Engineer from its inception in 1903 to 1926 inclusive. Thereafter, the work continued to enlarge with the increase in population and use of water. Cooperative programs, especially with the U.S. Geological Survey, gained momentum, especially in the field of ground-water studies, as is detailed later. The work of close cooperation with all Federal agencies concerned with water and soil resources of the State became an important factor in the operations of the State Engineer. Then, too, the Nevada State Legislature, from time to time, added additional duties to the office.

However, the basic function of the office remained the same, although, as noted above, the work was greatly increased. These functions are:

1. Processing water-right applications.
2. Adjudication of vested water rights.
3. Distribution of water on adjudicated streams.
4. Related and miscellaneous work.

Processing Water-Right Applications

The processing of applications to appropriate water includes an index system showing the location of the source of water applied for on township cards, name of the source, and the applicant's name. The map, prepared by a licensed State water right surveyor supporting the application, is carefully checked. If found in proper order, the notice of application is published in a newspaper of general circulation in the county within which the source of water is located. Within a certain period, protests may be filed by anyone claiming any prior right. A field investigation would be made and if the matter couldn't be resolved at that time, a hearing would be held.

Adjudication of Vested Water Rights

The adjudication procedure of vested water rights, as it has been provided by law since 1913, is a more complicated system than that of handling applications to appropriate water. The method set up prior to 1913 was declared unconstitutional by the Nevada Supreme Court. Some of the sections of the 1913 act were subsequently found to be unconstitutional and had to be corrected. However, the data found in the pre-1913 adjudications were utilized in the later determination. Many of the water rights on smaller streams were established as a result of civil actions in District Courts.

The determination of priority of water rights was, at first, concentrated on the Carson, Truckee, Humboldt, Walker, and Muddy Rivers. Up to about 1960, the State Engineer undertook the adjudication of a stream, usually at the requests of water users in areas of conflict. However, in later years the State Engineer inaugurated a Statewide program of adjudication.

Distribution of Water on Adjudicated Streams

The distribution of water was and has always been a matter of vital importance to water users, especially during dry years. Since early days, this has been one of the major functions of the Office of State Engineer. The first distribution of water by water commissioners under the direction of the State Engineer occurred during the summer of 1905 on the Carson River. By that time most of the priorities of water rights had been determined. Water commissioners were appointed by the Board of Irrigation upon request of the water users. The Board of Irrigation was created in 1901 (Chapter 59), and the 1903 Nevada Irrigation Law (Chapter 4) made the State Engineer a member of the board.

During 1907 and 1908, at the request of the water users, water was distributed on the East and West Forks of the Carson, Muddy, and Lower Humboldt Rivers, and Genoa Creek.

Related and Miscellaneous Work

Carey Act

During the years 1908 through 1912 the work involved in acting upon Carey Act projects, in cooperation with the Office of Surveyor General, required considerable time. The Carey Act, as it was applied in Nevada, is described in appendix 3.

Cooperative Stream Measurement

During early years of the Office of State Engineer, 1903 to mid-1908, stream-measurement work was carried on under a cooperative program with the U.S. Geological Survey. After mid-1908 no working agreement existed owing to the fact the legislature failed to appropriate any matching funds. However, the 1913 legislature appropriated \$5,000 in matching funds for the 1913-14 biennium, and this program has continued to the present day.

Snow-Survey Work

The development of this program, which is presently world-wide, was initiated by the University of Nevada Agricultural Experiment Station under direction of Dr. J.E. Church, Jr., and his assistant Professor H.P. Boardman.

Ground Water

During the 1903-26 period little consideration had been given to the ground-water resources of Nevada, other than a very hasty reconnaissance of ground-water possibilities by Ira MacFarland in 61 valleys in Nevada during 1918. Earlier, during 1912, State Engineer William Kearney made a general reconnaissance of the Las Vegas ground-water basin. State Engineer James Scrugham indicated his general knowledge and interest in the ground-water resources of Nevada in the 1919-20 Biennial Report.

Other Related Work

Often the State Engineer was called upon by one of the State departments or by a legislative act, to serve as a consultant for some projects. Some of these projects which involved the services of the State Engineer, have been heretofore noted.

An Aside

In the 1909-10 Biennial Report, State Engineer Emmet Boyle listed an inventory of all equipment and supplies of his office as of December 31, 1910. The list was all inclusive and contained such items as waste-paper baskets, a revolving stool, stamps on hand, together with field and stable equipment. Under the latter he listed two horses, one set light buggy harness, two buggies, one whip, two horse blankets, and one light buggy robe. All this stable equipment was stored at the Cleveland Ranch in White Pine County, with exception of one buggy which was stored in Carson City. The author looked in vain to find a listing of spittoons. When the office was moved in the early 1950's the author salvaged an old and much used one that must have been there from the beginning.

The mode of travel by the State Engineer or his assistants, was no doubt by railroad to a station nearest his destination and then by buggy or horseback. When the automobile first was used by the State Engineer is not known by the author. No doubt, it was a gradual transition, and according to budget listings probably started about 1915.

1927-39

In this section, day-by-day activities of the Office of State Engineer are not stressed, but rather some of the added duties of the State Engineer and events leading up to the 1939 Underground Water Act are set forth. Following this, the interesting history of the implementation of this law and the cooperative program with the U.S. Geological Survey is told.

With a change of State administration in 1927, Governor Fred B. Balzar¹ appointed George W. Malone² as State Engineer. Mr. Malone served through Governor Balzar's second term until May 28, 1935. He appointed Harry W. Reppert as Assistant State Engineer. Mr. Reppert served in that capacity until his death in early 1942. Mention is made here of Harry Reppert as he directed all the functional duties of the office and established many of the policies that later followed. The author had the privilege of working as Deputy State Engineer with Mr. Reppert from 1935 to 1942.

A large part of State Engineer Malone's time was taken up on affairs directly obligatory to his office, such as being secretary to the Colorado River Development Commission of Nevada, a member of the Nevada Public Service Commission, and commissioner of the State Irrigation District Board. During his term of office Mr. Malone was one of the leading figures in the organization of the Association of Western State Engineers. He served as a member of the 1929 Range Commission and was appointed by President Herbert Hoover as a member of the Committee on Conservation and Administration of the Public Domain.

State Engineer Malone wrote about his activities as secretary of the Colorado River Development Commission and preparation of the Colorado River Compact. He noted his work as the engineering member of the Public Service Commission involved holding most of the hearings away from Carson City.

In the following pages, some matters are discussed from the biennial reports of this period. The biennial reports, starting with the 1927-28 edition, became more inclusive, covering all aspects of activities of the State Engineer and his staff.

During the biennium 1927-28, a total of 841 applications were filed to appropriate water. Most of the applications were for stock-watering purposes as the result of the 1925 Stock Watering Act being held constitutional in early 1927.

Underground Water

As indicated earlier in these pages, the State Engineers had been only slightly involved with ground-water resources of the State, but all were concerned about the future value this water source would have to the economy of the State. Mention has been made of the brief study made of the Las Vegas Valley artesian basin as reported in the 1911-12 Biennial Report by State Engineer William Kearney; and of the reconnaissance survey made by Ira MacFarland during 1918 of 61 ground-water basins in Nevada, as reported in the 1917-18 Biennial Report by Seymour Case.

¹ Governor Balzar died March 21, 1934. The balance of his term was filled by Lieutenant Governor Morley Griswold.

² George W. ("Molly") Malone served as U.S. Senator from Nevada from 1947 to 1959.

Not until 1935 was the State Engineer given any responsibility as to the control of artesian wells. This was provided under Chapter 184, Statutes of 1935, which amended Chapter 210, Statutes of 1915. Under the latter act, the matter of control of artesian wells, type of casing, etc., was placed in the hands of the several district attorneys.

The 1929-30 Biennial Report by State Engineer Malone contained 231 pages, covering all aspects of the operation of his office, and presented considerable data not previously documented. Among the subjects discussed were:

- The history of the Colorado River Development Commission.
- The report of the Committee on Conservation and Administration of the Public Domain which was appointed by President Herbert Hoover. George Malone was the member representing Nevada.
- A report on upstream storage investigations on the Truckee, Walker, Carson, and Muddy Rivers.
- A detailed description of the Irrigation Districts and Canal Companies in Nevada.

The most important item presented was a long article on underground water, which quotes from a bulletin published by the University of Nevada Agricultural Experiment Station, written by F.L. Bixby and George Hardman.¹ Mr. Malone, in presenting this article, stated "This bulletin contains the latest published data on the underground-water resources of the State and is quoted for the purpose of rounding out the information that has been gathered by the State Engineer's office during the past biennium."

Historic Runoff of Nevada Streams

The 1929-30 Biennial Report contains what appears to be a rather complete record of all the streamflow measurements made in Nevada by the U.S. Geological Survey covering the Colorado River Basin, Snake River Basin, Great Basin, and minor basins.

Biennial Reports, 1931-34

The 1931-32 Biennial Report contains another chapter on underground water. Mr. Malone wrote:

"The underground waters of Nevada, except flood water which may hereafter be stored by construction of expensive reservoirs, now form practically our only potential future supply."

¹ F.L. Bixby, Senior Irrigation Engineer of the Irrigation Division, Federal Bureau of Public Roads; George Hardman, Nevada Agricultural Experiment Station, served as the head of the U.S. Soil Conservation Service in Nevada. During 1957, the author appointed him assistant director, Nevada Department of Conservation and Natural Resources, and he served until the author's retirement in 1965.

Mr. Malone presented a number of recommendations for the forthcoming legislature to consider. Among these was one pertaining to ground water:

"That the sum of \$5,000 be appropriated as a special fund to be expended in underground water investigations under the direction of the State Engineer and the State Board of Irrigation." (The legislature failed to accept this recommendation).

Other recommendations referred to funds for stream-gaging and snow-survey work.

In the 1932-34 Biennial Report, the State Engineer tried to assemble all the data so far compiled concerning ground water. It quotes extensively from the report of the University of Nevada Agricultural Experiment Station by F.L. Bixby and George Hardman. Included are estimates of annual increment of underground water recoverable in whole or part in southern Nevada, and the 1930 precipitation map of Nevada prepared by George Hardman.

While most of the data contained in this chapter have been included in previous biennial reports, excerpts from the report made by Ira MacFarland in 1918 and referred to in the 1917-18 Biennial Report of Seymour Case have been added. Mr. MacFarland's report covered about 61 valleys, whereas the Malone listing covered 90 valleys. A short description as to location, natural characteristics, including the elevations, geological structures, etc., was given.

This brings the reader to the end of the George Malone years as State Engineer--a period in which great strides were made in the administration and development of the natural resources of the State.

The Years 1935-39

Richard Kirman, Sr., was elected Governor of Nevada in November 1934 and served in that capacity through 1938. He never sought re-election. Governor Kirman appointed Alfred Merritt ("Tom") Smith as State Engineer on May 28, 1935, and he served until 1951. Mr. Smith retained Harry Reppert as Assistant State Engineer and appointed the author as Deputy State Engineer.¹

On April 1, 1935, the 1915 act of the Nevada State Legislature, Chapter 210, provided for conservation of underground water and included a provision for the prevention of waste of water from artesian wells, and made it the responsibility of the respective district attorneys to handle complaints. This was amended in 1935, Chapter 184, and subsequently gave the State Engineer the administrative duties in carrying out the provisions of the act.

The bill creating the 1935 amendment was introduced by an assemblyman from Clark County, where a large number of artesian wells had been drilled, many of which were wasting water, primarily due to faulty well construction or not being capped. No steps were made by the State Engineer to control the leaky or uncapped wells within the Las Vegas Valley until 1938 because of insufficient personnel and funds.

¹ Harry Reppert died February 28, 1942. The author was promoted from Deputy to Assistant State Engineer. Edmund Muth was named Deputy State Engineer.

Again, in 1937, the 1915 act previously mentioned, and the 1935 amendment, gave the State Engineer additional powers to enforce regulations as to drilling of wells in any proven artesian basin and control of artesian wells to prevent underground leakage and waste of water from flowing wells. It was not until the summer of 1938 that the Office of State Engineer started active work in Las Vegas Valley leading to eventual control of artesian wells in that area. The history of early activities by the State Engineer in the Las Vegas Valley is chronicled later in this section.

Colorado River Commission

An act creating the Colorado River Commission of Nevada was passed by the legislature March 20, 1935. The commission consisted of five members of which the Governor was chairman and the State Engineer, secretary. This commission replaced the earlier Colorado River Development Commission. State Engineer Smith, as secretary of the commission, carried the major load of the work of the commission, which for a number of years took up a large part of his time.

Nevada State Planning Board

Acting on the suggestion of Harold L. Ickes, U.S. Secretary of the Interior, early in February 1935, Governor Richard Kirman appointed a State Planning Board. Shortly after organization, the board proposed the introduction of a bill in the Nevada State Legislature for the purpose of providing the board with legal standing. No action was taken by the legislature until the 1937 session. Chapter 102, Statutes of 1937, gave the State Planning Board legal status as a State organization. The act provided that the board would consist of 11 members, 8 of whom would be appointed by the Governor, and 3 to be members ex-officio. The Governor, the State Engineer, and the state highway engineer were the ex-officio members.

Special Reports

In a number of instances biennial reports of the State Engineers have contained special articles concerning the land and water resources of Nevada. This is especially true subsequent to the 1927-28 Biennial Report of State Engineer George Malone. These articles contain valuable information concerning the history and development of water and land resources of Nevada, much of which can only be found in these reports. Rather than attempt to detail in these pages the subject matter contained therein, the author includes in appendix 5 an index of some of the reports that should be of interest, giving the particular biennial report wherein each article can be found.

Testing for Leakage in Wells in Las Vegas Valley

In the latter part of 1938, State Engineer Alfred Merritt Smith and his staff, realizing the seriousness of the underground-water situation in Las Vegas Valley, took the first step leading to the enactment of an underground water law and full-scale cooperative program with the U.S. Geological Survey, covering the Las Vegas Valley artesian basin. At that time no effort had been made by the Office of State Engineer to control free flow from a large number of wells that were wasting water because of the lack of any controlling device on the wells. It also appeared that considerable underground leakage existed from some of the wells.

The reason for the inaction on the part of the Office of State Engineer was that no lawful means were provided by which such control could be handled. Then, too, there seemed to be little concern on the part of Clark County, City of Las Vegas, and Las Vegas Land and Water Company that a serious water problem existed.

In fact, the general belief among the population was that the underground water resources were unlimited. The author was told on a number of occasions by the manager of the Las Vegas Land and Water Company that he was convinced that the ground water had its origin in Walker Lake, 350 miles north, and that he had no concern as to the Las Vegas ground-water basin being depleted. The author, having lived in Las Vegas from 1929 to 1934 and having done survey work there, was well acquainted with the great waste of water, leaking wells, and the history of decreasing artesian pressures throughout the valley. It was decided the first thing to do was to determine the extent of underground leakage and waste from free-flowing wells.

State Engineer Smith contacted O.E. Meinzer, Geologist in Charge, U.S. Geological Survey, to determine if the Survey could enter into a cooperative program for such a study, providing that matching funds would be available. Mr. Smith assigned the author the task of raising the matching money needed for such a study.¹ Clark County, City of Las Vegas, and Las Vegas Land and Water Company readily approved of the study and made the necessary funds available. Mr. O.E. Meinzer of the U.S. Geological Survey assigned Penn Livingston, engineer and an expert in this type of work, for the study. Penn Livingston was assisted in his work by Harry Jameson of Las Vegas, who had been working for George Hardman at the Nevada Agricultural Experiment Station in Las Vegas and was very knowledgeable of the artesian wells in the Las Vegas Valley.²

The field work, consisting of a study of the leakage of water from 42 wells in the valley, was made from August 11 to September 13, 1938. The amount of leakage from the wells was determined by a special current meter designed for this purpose by the U.S. Geological Survey.

Mr. Livingston found leakage from the wells examined quite small, amounting to about 30 gallons per minute, mostly from three wells. However, a large amount of water from uncapped wells was observed to be running to waste on the desert floor. The report of this study was titled *Underground Leakage from Artesian Wells in the Las Vegas Area, Nevada*, U.S. Geological Survey Water-Supply Paper 849-D, by Penn Livingston, 1941.

¹ The author represented the Office of State Engineer in the handling of all cooperative programs with Federal agencies, until his retirement as director of the Nevada Department of Conservation and National Resources in January 1965.

² Harry Jameson served as the artesian-well supervisor for Las Vegas Valley from May 1, 1943, to his death May 14, 1954. He also served in the same capacity for Pahrump Valley, Nye County, for about the same period.

Following the Penn Livingston report on well leakage, the State Engineer realized the necessity of controlling uncapped wells that were flowing freely, without any beneficial use being made of the water. To do so, it would be necessary to engage services of a man to contact the owner of such wells and request them to install caps or valves on the flowing wells. Clark County, City of Las Vegas, and Las Vegas Land and Water Company agreed to provide sufficient funds to engage the services of one man for 5 days each month. Harry Jameson was given this job and acted under the direction of the State Engineer. It was reported in the 1938-39 Biennial Report that Mr. Jameson's efforts in closing wells that were wasting water resulted in a saving of about 750,000 gallons of water a day.

Comprehensive Underground Water Act

The 1939 Underground Water Act was approved by the Nevada State Legislature March 25, 1939. There was little trouble in obtaining approval of this act, mainly as the result of the activities of the State Engineer in the Las Vegas Valley artesian basin, starting with the U.S. Geological Survey study by Penn Livingston. Also, the work of Harry Jameson in restricting a great loss of water from free-flowing wells and the cooperative attitude of the Clark County, City of Las Vegas, and Las Vegas Land and Water Company were most helpful. In addition, the State Engineer and the author carried on a publicity program giving talks before service clubs in Las Vegas.

In working out a preliminary draft of an underground-water law, the author borrowed, to a great extent, from the existing ground-water codes of Utah, New Mexico, and Oregon. The final draft that was presented to the legislature was prepared by Deputy Attorney General William T. Matthews under Attorney General Gray Mashburn.

The 1939 Nevada Underground Water Act has been amended a number of times and now is considered one of the most comprehensive ground-water laws in the West. The 1939 act repealed the 1915 act and the amendatory acts of 1935 and 1937. Only a few of the salient provisions of the present law are presented herewith: The law provides that all underground water within the boundaries of the State belong to the public and are subject to appropriations for beneficial use under the laws of the State. Upon receipt by the State Engineer of a petition requesting him to administer the provisions relating to designating specific areas in a valley, he may so designate. In such designated areas the State Engineer may appoint a well supervisor. The Board of County Commissioners shall levy a special tax upon all taxable property within the designated area to pay the salary of the well supervisor. In such designated areas anyone desiring to drill a well, for other than domestic purposes, shall first obtain a permit to appropriate water.

The provision relating to the drilling of a well didn't apply to a domestic well where the draught does not exceed a daily maximum of 1,800 gallons. (Note: Originally, the daily maximum allowed for a domestic well was 2 gallons per minute or 2,880 gallons per day.)

Provisions were made for the repair of faulty wells in case the owner fails to comply. In designated areas, and when necessary, the State Engineer may determine preferred uses of water. Licensing of well drillers and filing logs of wells was made mandatory.

Although other provisions in the law are not mentioned here, it is sufficient to say that the law as it now exists gives the State Engineer complete control of ground-water resources of the State. In any basin, when the State Engineer is of the opinion that control is needed to protect ground-water levels, he may designate such areas, even though no petition is presented by the water users.

In the early years following the enactment of the 1939 act, the only basins designated by the State Engineer were the Las Vegas (January 16, 1941) and Pahrump (March 11, 1941) valleys in Clark and Nye Counties, respectively. At the present time, additional designated basins exist, the principal reason being to minimize overdraft of available ground-water supplies.

Survey of well locations

Following the enactment of the 1939 act and engaging the employment of Harry Jameson, the State Engineer embarked on a program of indexing all wells in Las Vegas Valley, as to name of owner, location, permit number, year drilled, depth, and discharge. The list contained 340 wells. During the early 1940's, a map of the Las Vegas artesian basin was made in the Office of State Engineer, showing the location of the wells by serial numbers.

Of the 340 wells listed, only 71 had permits at that time to appropriate, and most of these were on wells drilled in the late 1930's and early 1940.

1940-43

Ground-Water Use in the Las Vegas Valley

The 1940-42 Biennial Report stated that the work carried on in the Las Vegas Valley had brought about repair of many leaky wells, with a saving of over 2 million gallons of water daily. Also, the owners of many wells that had previously been drilled, on which no application for permission to appropriate water had been filed, made applications and received permits to appropriate water. During this period, 48 new wells were drilled in the valley, all having been granted permits. An updated listing of wells in 1942 showed a total of 388 wells in the valley, 130 having permits. This list does not include the large number of domestic wells which required no permits to appropriate water.

The large increase of population brought about by U.S. Department of Defense projects in and around Las Vegas resulted in a greatly increased use of water. During the first week of September 1942, Edmund Muth, Deputy State Engineer, assisted by Harry Jameson, made well-discharge measurements on approximately 50 of the larger wells and also made estimates as to the total amount of water being used. The study showed that nearly 17 million gallons of water were being used daily from the wells measured. Adding an estimated 10 percent for the many smaller unmeasured wells brought the total to more than 18 million gallons per day, or nearly 29 cubic feet per second. This was estimated to be the maximum daily use at that time. It was estimated that the yearly use was on the order of 15,000 acre-feet.

State Engineer Designates Las Vegas and Pahrump Valleys

Upon receipt of a petition signed by a sufficient number of well owners having a legal right to appropriate underground water in the Las Vegas Valley and pursuant to Section 4 of the 1939 Underground Water Act (Chapter 178, Statutes of 1939), the State Engineer on January 10, 1941, designated the Las Vegas Valley artesian basin by legal subdivisions. With this action the State Engineer could proceed with administration of the 1939 act. Subsequent development of artesian water outside of the designated area caused the State Engineer to make supplementary designations thereafter.

Section 5 of the 1939 act, as amended in 1943, provided that the State Engineer could employ an artesian-well supervisor whose salary would be paid from a special tax levied against all taxable property within the designated area. It was also provided that such salary could first be paid by the State Engineer from the water distribution fund created by Chapter 232, Statutes of 1931, as amended by Chapter 23, Statutes of 1943, pending the levy and collection of the tax as provided in this section.

In March of 1943, the Clark County Commissioners approved a budget of \$5,000 and the following year a budget of \$6,500. On May 1, 1943, Harry Jameson was employed as artesian well supervisor for the Las Vegas Valley artesian basin. Under Mr. Jameson's supervision many wells in the Las Vegas Valley were repaired and supervision was exercised over the drilling of new wells.

On March 11, 1941, the State Engineer designated an area containing large-capacity wells in the Pahrump Basin, Nye County. Mr. Jameson was also appointed to supervise drilling of wells in this area with a yearly budget of \$250.

EVALUATION OF NEVADA'S WATER RESOURCES-- THE U.S. GEOLOGICAL SURVEY COOPERATIVE PROGRAMS

The Stream-Gaging Program

1889-1908

Mr. A.E. Chandler, the first Nevada State Engineer, stated in his 1903-04 Biennial Report that the U.S. Geological Survey began streamflow measurements in Nevada during 1889. Mr. Chandler wrote:

"As appropriations were small, the work was continued rather irregularly until 1900, when the funds available allowed the stream gagings to be well systematized. Until the appointment of the State Engineer [1903], the hydrographic work in Nevada was under the direction of L.H. Taylor, now Supervising Engineer for the Reclamation Service."

The cooperative stream-gaging program with the U.S. Geological Survey started in 1901 with the enactment into law of Chapter 59, Nevada Statutes of 1901. This act provided for a cooperative program with the U.S. Geological Survey for measurement of the discharge of streams in Nevada.

Thus, from 1901 to the present time, with the exception of the 5 years 1908-12, this cooperative program with the U.S. Geological Survey for stream measurements has been continuous. It is no doubt the longest cooperative program between the U.S. Government and the State of Nevada.

Regarding the early years, Mr. Chandler pointed out that inasmuch as Section 12 of the Irrigation Law of 1903 provided the State Engineer should measure all streams and ditches, an agreement was entered into between F.H. Newell, Chief Engineer of the U.S. Reclamation Service, and the State Engineer, whereby the State Engineer acted, without salary, as resident hydrographer of the U.S. Geological Survey. Under this agreement, all the U.S. Geological Survey stream stations on Nevada rivers and streams were placed under control of the State Engineer and all U.S. Geological Survey field assistants engaged in stream and ditch measurements reported to him directly. He noted:

"Although the law provides that the State Engineer shall be allowed 'actual traveling expenses' when 'called away from his office,' an old decree of the Supreme Court having construed 'actual traveling expenses' *not* to include hotel bills, the State Controller can allow no subsistence expenses. As such a construction is absolutely foreign to modern engineering and business practice, the United States Geological Survey, in return for his services as Resident Hydrographer, has paid the hotel bills of the State Engineer, when absent from Carson on business in connection with his office."

The 1889 stream measurements, as noted by Mr. Chandler, were made on several streams in California and Nevada, tributary to the Truckee River during May and June of that year. Mr. Chandler also reported that during 1903-04 regular stream-gaging stations had been maintained at 23 sites on 5 river systems: the Truckee River Basin, 9; Carson River Basin, 3; Walker River Basin, 3; Humboldt River Basin, 7; and Muddy River Basin, 1.

Continuous recording of stream measurements in the above mentioned river basins, with the exception of the Muddy River basin, started during 1901 and 1902 and continued to 1909 or 1910. The flow records between 1908 and 1913 are, in a number of cases, only fragmentary, because, as noted earlier, State money was not available. During those years, however, the U.S. Geological Survey maintained some key streamflow-measurement stations at Federal expense.

The 1911-12 Biennial Report by State Engineer William Kearney lists all available streamflow-measurement records up to that time. In addition to records from established stations, the tabulation lists a great number of miscellaneous measurements, including the 1889 measurements.

From 1907 through June 1908, streamflow-measurement stations were maintained at about the level as in previous years, with the exception of the Moapa River station, which was discontinued in 1906, as reported by State Engineer Frank R. Nicholas in the 1907-08 Biennial Report. He was appointed field hydrographer for Nevada by the Director of the U.S. Geological Survey.

Mr. Nicholas noted "after considerable correspondence with Mr. E.C. La Rue, District Hydrographer for Utah, Nevada, and Idaho, it was deemed advisable that this office discontinue its connection with the United States Geological Survey, as sufficient funds were not available in this office, nor through the office of the United States Geological Survey, for the further maintenance of this valuable department. Consequently, no regular measurements of rivers have been taken in this State since June 30, 1908." It was not until 1913 that the stream-gaging program was resumed.

Other stream measurements were carried on under a triangular arrangement between the U.S. Department of Agriculture, the Nevada Agricultural Experiment Station, and the Engineering Department of the University of Nevada. In addition, the field engineers of the Office of the State Engineer made spot measurements on a number of smaller streams.

1913-46

An act of the Nevada State Legislature during the 1913 session provided matching money for the State to resume the cooperative stream-gaging program with the U.S. Geological Survey, which had been dropped July 1, 1908, for lack of funding. This act is Chapter 181, Statutes of 1913.

The 1915-16 Biennial Report by State Engineer William Kearney reported that 34 streamflow-measurement stations were being maintained under the program. He stated, "Owing to the limited appropriation, only the more important streams can be studied. However, it is the desire of this office to continue work of measuring the available water supplies on each stream for a sufficient period of time to indicate what can be reasonably expected for irrigation and other purposes, after which new streams will be selected or studied."

From March 1913 to March 1916 the work was in the charge of Mr. E.A. Porter, District Engineer, U.S. Geological Survey, Salt Lake City, Utah. Appendix 4 contains a listing of U.S. Geological Survey personnel in charge of hydrologic program in Nevada.

Subsequent legislatures continued to support this cooperative program. The program continued to expand, and a total of 40 stations were in operation, as follows:

Humboldt River	18	stations
Pyramid and Winnemucca Lake basins	2	"
Walker Lake basin	5	"
Carson River basin	3	"
Muddy River basin	5	"
Snake River basin	4	"
Minor basins	3	"

From 1913 to 1926 the annual appropriation by the State was \$2,500. This amount was matched by the U.S. Geological Survey. Starting about 1919, the U.S. Bureau of Indian Affairs contributed costs for installation and operation of three stations, two on the Owyhee River and one on the Walker River near Wabuska, amounting to an average of \$300 per year.

Mr. A.B. Purton, District Engineer, U.S. Geological Survey for Utah and Nevada, in his report of the stream measurement program in Nevada for 1925-26 wrote as follows:

"The first systematic attempt to inventory the water resources of Nevada was the establishment in 1889 by the United States Geological Survey of a few gaging stations in connection with special studies relating to irrigation in the western states. . . . In 1905 a District Office of the Water Resources branch of the Geological Survey was established at Salt Lake City, and the work in Nevada and Utah is now carried on through that office. In order to increase the scope of the work the State Legislature has for several years made biennial appropriations to be expended in cooperation with the Geological Survey. In fact, on account of the limited Federal funds available, these State appropriations have been the only thing that has made systematic stream gaging in Nevada possible."

In 1927, the Nevada State Legislature reduced the State appropriations for cooperative stream gaging by one-half, from \$2,500 per year to \$1,250, greatly handicapping the program as it had been developed at that time. Mr. Purton also noted that funds for the cooperative stream-measurement work had been supplemented in a substantial way, not only by the U.S. Bureau of Indian Affairs but also by State water commissioners, irrigation districts, and private organizations. For the next 9 or 10 years, the program was confined to efforts to continue operation of as many stations as possible. The number of gaging stations operated during the 1927-40 period averaged about 16.

The 1936-38 Biennial Report of the State Engineer contained the following excerpt from Mr. Purton's report:

"In earlier years the State appropriated \$2,500 a year for the investigation of its water resources to be carried on in cooperation with the United States Geological Survey which supplied a like amount of funds. This sum was gradually reduced until for some time only \$750 a year has been appropriated for this work. It is apparent that no comprehensive program can be carried on for \$1,500 a year in a State the size of Nevada."

The author became well acquainted with Mr. Purton and a great deal of credit is due him for keeping the stream-measurement program moving in the right direction, although as earlier noted, State matching funds decreased to a low of \$750 per year during the 1936-43 years. Starting in 1944, the State matching funds gradually increased and by 1957 amounted to \$11,250 per year.

Mr. M.T. Wilson, District Engineer for Utah and Nevada, U.S. Geological Survey, stated that in 1943 a total of 11 river and reservoir gaging stations were being operated with State matching funds, the Bureau of Indian Affairs was furnishing funds for four stations, and Federal funds had been furnished by Congress since 1928 for stream measurement, silt determination, and quality-of-water studies in the Colorado River basins. Mr. Wilson also noted the Newlands Project of the U.S. Bureau of Reclamation had been furnishing records on the Carson River at Fort Churchill, and Mr. H.C. Dukes, Federal Watermaster, furnished records for the Truckee River. During this period, Mr. Wilson reported that the Humboldt River water users made \$1,650 available for construction or rehabilitation of four stations on the Humboldt River and one on the Little Humboldt River.

In a paper presented at the 1946 Nevada Water Conference, Mr. M.T. Wilson stated that water-resources investigations in the State of Nevada had greatly improved during the past 3 years, but were still not of sufficient magnitude for the proper administration, distribution, and planning for new irrigation, power, and flood control projects. He also noted that in recent plans for developing additional irrigation supplies, power, and flood-control projects, both the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers had experienced difficulty in correlating existing streamflow records. A meeting held in Reno in June 1946 with interested Federal agencies resulted in the recommendation that all streamflow-measurement activities in the Truckee and the Lower Carson River basins be included in a cooperative program under technical supervision of the U.S. Geological Survey.

A small increase in State cooperative funds, together with contribution from water users, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and U.S. Bureau of Indian Affairs, allowed the Survey to greatly enlarge its stream-measuring program. The 1944-46 Biennial Report reported that 45 river and reservoir gaging stations located in and adjacent to Nevada were being operated. Thirty of these were financed by State-Federal cooperative funds, seven by the U.S. Geological Survey, and the remaining eight stations were funded by other Federal, State, and private organizations. The biennial report contains a description of all the active stream-gaging stations as of 1945.

1946-49

During 1946-47, the U.S. Bureau of Reclamation installed seven stream-gaging stations on the East and West Carson Rivers and one on the Little Truckee River, all in California, and the U.S. Army Corps of Engineers financed the construction of three stations, one each on the East and West Walker Rivers, and one on the Truckee River near Reno.

Because the State-Federal matching money was inadequate to fund construction and operation of the 11 stations requested, the Army Corps of Engineers made funds available for 3 stations and the Bureau of Reclamation allotted funds for installation of 8 stations and operation funds for 1 year. The State of California made available \$1,000 to assist in the operation of eight stations situated in California.

The increased program of stream measurement by the U.S. Geological Survey in Nevada made necessary the establishment of a Surface Water Branch Office in Carson City, to more efficiently administer the program. The office was established in 1947, and Mr. L.R. "Tom" Sawyer, Engineer in Charge, was appointed to supervise the Nevada work. He was assisted by two engineers and one clerk. One engineer, Wilson McConkie, was stationed in Elko, and Don Clendenon operated out of the Carson City office. At that time all basic data collected for the past several years and files related to surface-water investigations were transferred from Salt Lake City to Carson City. Only the administrative supervision and personnel assignments were handled by the District office in Salt Lake City.

With the engineer in charge having an office in Carson City, the State Engineer and the U.S. Geological Survey could more readily work out mutual programs. One of the greatest advantages was that it enabled the Geological Survey to work out mutual cooperative programs with local water-user organizations, thus increasing the size of the program and obtaining statewide information on the water resources of the State.

During 1948, the number of stream- and reservoir-gaging stations operated by the U.S. Geological Survey in Nevada numbered 61 and were in the following basins:

Humboldt River basin	22	stations
Owyhee basin	4	"
Colorado River Main Stem	2	"
Carson River basin	12	"
Pyramid and Winnemucca Lakes basin	8	"
Walker River basin	8	"
Minor basins	2	"
Salmon Falls Creek basin	1	"
Virgin River basin	2	"

The Nevada Water Conference, held November 17-18, 1949, was highlighted by a talk by Carl G. Paulsen, Chief Hydraulic Engineer, U.S. Geological Survey, Washington, D.C. Among the many topics discussed by Mr. Paulsen, mention was made of the important role played by the Association of Western State Engineers in the matter of water-resources investigation. He remarked as follows:

"The Association of Western State Engineers was organized in 1926 or 1927. George Malone, former State Engineer and new Senator from Nevada, was the first President of the organization. It has been largely through the efforts of that organization that has been instrumental in bringing about a reasonable comprehensive and uniform water investigational program throughout the United States.

"That is an accomplishment for which the Association of Western States should be given great credit. The States have taken the responsibility for initiating general water-resources investigations throughout the country that the Federal Government would probably not have undertaken without the insistent urging from the various states. As a result the Geological Survey has for many years been brought into the program on a national scale and is the agency primarily responsible for the collection and publication of the basic water-resources data of the country. . . . Without the splendid cooperation that is given to the Survey by the various States and those Federal agencies interested in our National water problems, much less would have been accomplished thus far in building up the factual information of the Nation's water resources . . ."

1956-62

The establishment of a Surface Water Branch office in Carson City and the financial support furnished by cooperating agencies brought about a rapid increase of streamflow-measurement stations. During 1956, the following State and local water users contributed matching or transfer funds:

Bridgeport Water Users District
Bunkerville Irrigation Company
California Department of Water Resources
Carson River Irrigation District
Colorado River Commission of Nevada

Franktown Creek Water Users
Humboldt River Water District
Mesquite Irrigation Company
Muddy River Irrigation Company
Nevada Office of State Engineer

Pershing County Water Conservation District
Petan Company
Salmon River Canal Company
Truckee-Carson Irrigation District
U.S. Army Corps of Engineers

U.S. Board of Water Commissioners, Walker River
U.S. Bureau of Indian Affairs
U.S. Bureau of Reclamation
U.S. Navy
U.S. Soil Conservation Service

Walker River Irrigation District
Office of State Engineer of Utah

The 1957-59 Director's Report of the Nevada Department of Conservation and Natural Resources contained a statement by C.H. Carstens, Engineer in Charge, U.S. Geological Survey, outlining the procedure used in establishing new gaging stations. He wrote as follows:

"The Geological Survey is designing its surface-water program around a hydrologic network of stream-gaging stations that will give maximum hydrologic information for the funds and effort expended. The program is built around a small group of selected primary stations which would be operated on a continuing basis to establish long-term runoff patterns. The primary stations would be supplemented by operating a larger group of secondary stations for short periods of time, possibly 5 or 10 years, and then correlating the data from the short-term or secondary stations with records from the primary stations."

During the 1961-62 water year the regular program consisting of 107 stream, 9 reservoirs, and 4 lake gaging stations was augmented by 50 partial-record stations operated in cooperation with the Nevada State Highway Department to obtain flood data.

During subsequent years, the U.S. Geological Survey increased its scope of work to address the information needs of the many problems that developed.

Before closing this section on the work of the Surface Water Branch of the U.S. Geological Survey in Nevada, it seems appropriate to give a little of its history. In an address by O.M. Hackett, Chief, Ground Water Branch, Water Resources Division, U.S. Geological Survey, Washington, D.C., at the Sixteenth Annual Water Conference held in Carson City, September 27-28, 1962, some interesting facts were disclosed. Only excerpts from Mr. Hackett's talk are given here. In introducing the subject he stated:

"On this occasion it is fitting to note that 75 years ago, in 1887, the State of Nevada returned to the United States Senate a man by the name of William Stewart. One year later Big Bill Stewart was largely responsible for the passage by Congress of a joint resolution that led to the establishment of the Irrigation Survey of the Arid Lands as a part of the Geological Survey. The Irrigation Survey was the progenitor of the present Water Resources Division and its operating branches.

"Allied with Senator Stewart in securing passage of the resolution that established the Irrigation Survey was John Wesley Powell, who had been instrumental in the founding of the Geological Survey and was its second Director . . .

"Major Powell's diverse interests led to the inauguration of many activities, some of which were basis for the establishment later of other Federal agencies. His interest in the Indians led to the establishment of the Irrigation Survey and later the Reclamation Bureau . . . He was interested in stream pollution and the Survey began studies later transferred to the U.S. Public Health Services. He was interested in mining geology and technology, and Survey activities in this field were the basis for the establishment of the U.S. Bureau of Mines. He was interested in forests and the Survey began studies that later were transferred to the Forest Service. He was interested in the natural wonders of the West, and survey activists in this line promoted establishment of the National Park Service."

Mr. Hackett then continued:

"The Geological Survey requested the transfer of many of these activities it initiated because they involved construction, planning, administration, and policing. Powell and other early leaders recognized that it would be extremely difficult, if not impossible, for the Survey to maintain an unbiased position with respect to the collection and interpretation of basic scientific information on natural resources if it continued to engage in construction, policing, and related activities. Thus, by the transfer of these activities, was established the principle that a research agency of government, to merit the public confidence, should endeavor to avoid activities that might lead to suspicion of bias or partiality."

Under the heading "A Time of Beginnings" Mr. Hackett told about some of the history of the early activities of the Water Resources Division:

"The history of the Survey's water-resources activities began with the establishment of the Irrigation Survey. The first studies were initiated in 1888 at Embudo, New Mexico. Here in December, a field camp was established where men were to learn how to gage streams. There were, to be sure, unforeseen difficulties. For example, the first meter, and a poor one at that, was slow in arriving. The camp goat ate the black-bulb thermometer, and meteorological readings had to be suspended until the thermometer could be recovered at the expense of the goat. Nevertheless, the training period was completed successfully, and by June 1889, all men had been assigned to make studies in various parts of the West.

"The Irrigation Survey lasted only two years; but its contributions were significant. It was organized into a topographic survey and a hydraulic survey. Thus was established the principal that topographic mapping is a necessary adjunct to water investigation. Men trained at Embudo by the Hydraulic Survey formed the nucleus of what later became the Surface Water Branch."

It was earlier noted that the first State Engineer for Nevada, A.E. Chandler, reported that during May and June of 1889 streamflow measurements were made on seven streams tributary to the Truckee River in California and Nevada.

Mr. Hackett then stated that a great upsurge of national interest in water and water activities was brought about by the drought and depression days of the early 1930's and that, for the Water Resources Division, this was period of steady growth, principally along the lines dictated by immediate needs and these needs were for basic data.

The Statewide Ground-Water Program

In O.M. Hackett's address at the Nevada Water Conference in 1962 that is referred to above, he eulogized the pioneering work of the U.S. Geological Survey's O.E. Meinzer in the field of ground-water hydrology, with the following statement.

"Beginning shortly after the turn of the century, Meinzer had pioneered studies of ground water for the Geological Survey. His leadership, over a span of some 40 years, transformed these investigations from a geologic and engineering sideline to a full-fledged science. In the words of W.E. Wrather, former Director of the Survey: Meinzer did for ground-water hydrology what Emmons¹ did for mining geology. He showed how sound geologic observations and well established geologic theory coupled with precise engineering analysis could be applied effectively to problems of water finding and to the calculation of reserves."

Some of this pioneering work directly involved the ground-water resources of Nevada. O.E. Meinzer's report in 1917 on the *Geology and Water Resources of Big Smoky, Clayton, and Alkali Springs Valleys, Nevada* (U.S. Geological Survey Water-Supply Paper 423), is considered one of the early classics and set an example of ground-water reporting that is followed to this day, nationwide.

For many years, the Office of State Engineer felt the need of an extensive hydrologic study of the Las Vegas Valley artesian basin. Such a program had been discussed on several occasions with the U.S. Geological Survey in Washington, D.C., and Salt Lake City, Utah. During the spring of 1943, State Engineer A.M. Smith made a request to O.E. Meinzer, Director, U.S. Geological Survey, Ground Water Branch, to have a ground-water geologist assigned for the Las Vegas study. This action resulted in a cooperative-program agreement between the State of Nevada and the U.S. Geological Survey signed June 29, 1944, whereby each party contributed an amount of \$5,000. In this instance the State acted on behalf of Clark County, and the amount contributed was furnished from the Las Vegas Valley artesian basin fund. The State was allowed credit on Mr. Jameson's salary as part of the cooperative fund.

Dr. Meinzer assigned George B. Maxey, assistant geologist, to make this study. He was aided by long-time Las Vegas resident, Harry Jameson. Field work on the ground water in the Las Vegas Valley was started in July 1944 and ended in July 1945. Supervision was afforded by P.E. Dennis, Geologist in charge of ground-water studies in Utah.

The final report of the Las Vegas study was contained in Nevada Water Resources Bulletin 5, *Geology and Water Resources of the Las Vegas, Pahrump, and Indian Spring Valleys, Clark and Nye Counties, Nevada*, by G.B. Maxey and C.H. Jameson, 1948.

¹ W.H. Emmons gained fame as a geologist with the Geologic Branch, U.S. Geological Survey.

By late 1944, with the Las Vegas Artesian Basin study under way, the State Engineer and his staff were of the opinion that a great need existed to determine the ground-water resources throughout Nevada. Accordingly, on October 26, State Engineer Smith called together all Federal and State agencies concerned with land and water for the purpose of discussing the proposed ground-water study and to obtain suggestions as to procedure. The meeting was held in the Hero's Memorial Building, Carson City, and was attended by 20 people representing the following agencies:

Nevada Agricultural Experiment Station
Nevada Cooperative Snow Survey
Nevada Office of State Engineer
Nevada Office of Surveyor General
Nevada State Highway Engineer

U.S. Bureau of Indian Affairs, Carson Indian Agency
U.S. Forest Service
U.S. Geological Survey
U.S. Grazing Service
U.S. Weather Bureau
Utah General Land Office

All present went on record as supporting the proposed program and offered the cooperation of their agency or department in carrying out such a statewide study. This gathering of Federal and State people concerned with all aspects of law and water resources of Nevada was the forerunner of the Annual Nevada Water Conferences, which have been held for many years.

During the interim from the aforementioned meeting to the next session of the Nevada State Legislature in January 1945, many key legislators, mainly from the "cow counties," were contacted about the suggested program. In all instances they were enthusiastic in their support.

As a prelude to establishing a statewide ground-water study, it was necessary to provide an enabling act to allow the State to enter into such a program with the U.S. Geological Survey. This was accomplished by enacting Chapter 117, Statutes of 1945. The act provided that the State Engineer for, and on behalf of, the State of Nevada could enter into agreement with the U.S. Geological Survey, the U.S. Soil Conservation Service, and any State agency for making stream measurements and underground water studies. The act repealed the Enabling Act contained in Chapter 59, Statutes of 1901.

During the same legislative session, an appropriation of \$35,000 was provided as matching money with the U.S. Geological Survey for underground water studies. By July 1, 1945, a Statewide cooperative program had been entered into with the U.S. Geological Survey. Thomas W. Robinson, an engineer with the U.S. Geological Survey, was appointed to serve as district engineer for Nevada.

When the District Office for the U.S. Geological Survey ground-water program was established in Nevada, it shared the basement of the Ormsby County Court House with the county jail.

When the Office of State Engineer was moved from the Hero's Memorial Building in 1952 to the Nye Building at 201 South Fall Street, the U.S. Geological Survey office occupied a portion of the second floor with the Office of State Engineer and the Public Service Commission. Again, in about 1958, the Office of State Engineer and U.S. Geological Survey offices were moved to the new Blasdel Building, just back of the State Capitol. During 1965, the offices of the Nevada Department of Conservation and Natural Resources were moved back to the Nye Building, 201 South Fall Street. In 1970, the U.S. Geological Survey offices were moved to the current (1990) main Federal Building.

In late 1945, the author, accompanied by Thomas W. Robinson, District Engineer, U.S. Geological Survey, made a trip to San Pedro, Calif., for the purpose of purchasing a well drilling rig as an aid to the ground-water studies. A rotary drill rig was purchased from surplus property, U.S. Department of Commerce, and shipped to Las Vegas. Two or three test holes were subsequently drilled in the Las Vegas Valley.

This particular program was abandoned later on, as it became difficult to obtain services of a competent well driller. It was also found more economical to contract with established well-drilling concerns.

By 1950, a network of about 250 observation wells were established in many valleys of the State. The water levels in these wells were measured twice a year. In addition, 15 automatic water-level recorders were installed.

From 1946 until 1961, all cooperative reports prepared by the U.S. Geological Survey and published by the Nevada State Engineer were designated as Water Resources Bulletins. The studies were made in valleys where development of ground-water resources was well under way and where enough basic data were available to allow geologists and engineers to make reasonable estimates of annual recharge and discharge of ground water.

Many of the valleys in Nevada had little ground-water development, other than perhaps an isolated well or two furnishing water for stock by means of a windmill. In other words, not enough data were available to develop a detailed report, yet the possibility remained of a sizable ground-water supply in many of the arid or semi-arid valleys of Nevada.

Officials of the State and U.S. Geological Survey conceived the idea for reconnaissance studies in the undeveloped valleys, using meager data that were available and employing empirical techniques for hydrologic evaluation. Consideration was given to the estimated precipitation on the watershed and the calculated amount of water reaching the ground-water zone. An evaluation was made as to the discharge of water from a valley by means of evapotranspiration, springs, and underflow out of the valley.

The Nevada State Legislature approved of such a cooperative study by the enactment of Chapter 181, Statutes of 1960. This act provided funds to the Nevada Department of Conservation and Natural Resources for a cooperative program with the U.S. Geological Survey for such reconnaissance surveys of the water resources in basins in Nevada not covered by detailed Bulletins. To date (1990), 42 Bulletins (table 3; fig. 1) and 60 Reconnaissance Reports (table 4; fig. 2) have been published. These reports together cover virtually all the valleys in Nevada.

TABLE 3.--Hydrologic reports published as Nevada Water-Resources Bulletins

Bulletin number	Area, subject, and year of publication
1.	(Number never assigned to a report)
2.	Lovelock Valley: ground water (1946)*
3.	Las Vegas Valley and other valleys: ground-water levels (1947)*
4.	Las Vegas and Indian Springs Valleys: well data (1946)*
5.	Las Vegas, Pahrump, and Indian Springs Valleys: geology and water resources (1948)*
6.	Las Vegas, Pahrump, and Indian Springs Valleys: ground-water summary (1947)*
7.	Meadow Valley Wash above Caliente: geology and ground water (1948)*
8.	White River Valley: ground water (1949)*
9.	(Never printed)
10.	Paradise Valley: ground water (1949)*
11.	Fish Lake Valley: ground water (1950)*
12.	Eastern Nevada: ground water (1951)*
13.	Buena Vista Valley: geology and ground water (1955)*
14.	Quinn River Valley: geology and ground water (1957)*
15.	Winnemucca Lake and Crescent Valleys: ground water (1961) [also WSP 1539-C]
16.	Kings River Valley: ground water (1963) [also WSP 1619-L]
17.	Fernley-Wadsworth area: ground water (1963) [also WSP 1619-AA]
18.	Las Vegas basin: hydrologic effects of development (1961)*
19.	Winnemucca area: hydrogeochemistry (1962)*
20.	Humboldt River valley: hydrologic properties of valley-fill sediments (1962) [also WSP 1669-M]
21.	Lower Humboldt River basin: hydrogeology (1963)*
22.	Winnemucca area: hydrogeology (1962) [also WSP 1754]
23.	Lake Mead Base: ground water (1963) [also WSP 1669-Q]
24.	Winnemucca area: water resources (1963)*
25.	Several area, northern Nevada: geophysical studies related to hydrogeology (1964)*
26.	(Never printed)
27.	Winnemucca area: water resources (1964)*
28.	Truckee Meadows: hydrogeology and hydrogeochemistry (1964) [also WSP 1779-S]
29.	Las Vegas Valley: hydrogeologic effects of development (1964)*
30.	Statewide: surface-water inventory (1965)*
31.	Kings River Valley: hydrologic effects of development (1966)*
32.	Humboldt River basin: hydrology (1966)*
33.	White River area: interbasin ground-water system (1966)
34.	Quinn River Valley: hydrologic effects of development (1966)*
35.	Diamond Valley: hydrologic effects of development (1968)*
36.	Statewide: estimating runoff in semiarid areas (1968)
37.	Hualapai Flat: hydrologic effects of development (1969)*
38.	Mason Valley: water resources (1969)*
39.	Paradise Valley: hydrologic effects of development. Tributary areas: hydrology (1970)*
40.	Statewide: proposed streamflow data program (1970)*
41.	Big Smoky Valley: water resources (1970)*
42.	Lemmon Valley: hydrologic effects of development (1972)*
43.	Smith Valley: hydrologic effects of development (1976)*
44.	Las Vegas Valley: hydrologic effects of development (1976)*
45.	Eagle Valley: mathematical model analysis (1986) [also OFR 80-1224]

* Report published only in Bulletin series. Unmarked reports were first published elsewhere; for example, as U.S. Geological Survey Water-Supply Papers (WSP) or Open-File Reports (OFR).

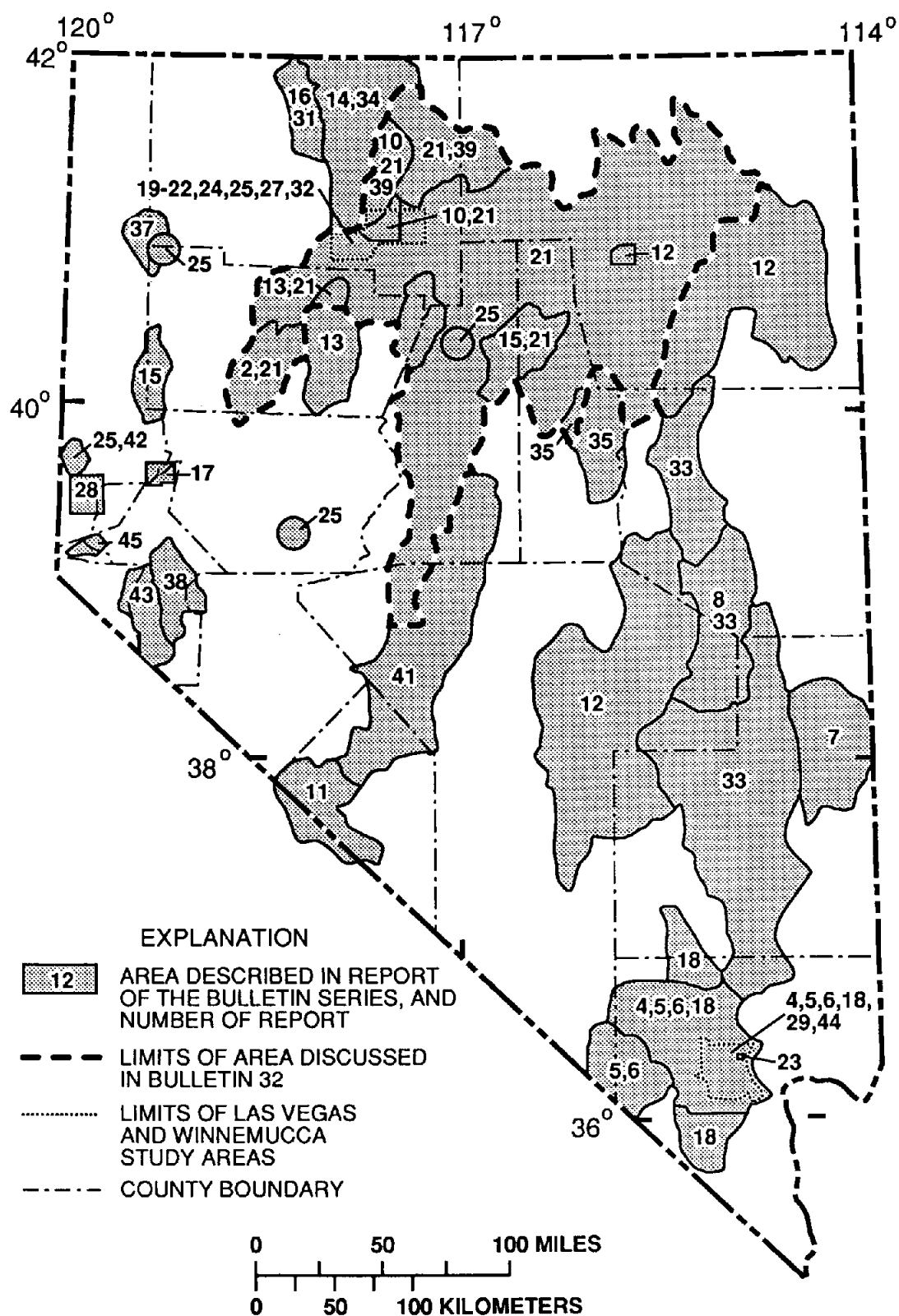


FIGURE 1.--Areas described in reports of the "Nevada Water-Resources Bulletin" series. Bulletins 30, 36, and 40 deal with entire State.

TABLE 4.--Hydrologic reports published in the Nevada Water-Resources Reconnaissance Series

Report number	Valley or area	Report number	Valley or area
1	Newark	36	Eldorado, Piute, and Colorado River
2	Pine	37	Grass (near Austin) and Carico Lake
3	Long	38	Hot Creek, Little Smoky, and Little Fish Lake
4	Pine Forest	39	Eagle, Carson City
5	Imlay area	40	Walker Lake and Rawhide Flats
6	Diamond	41	Washoe
7	Desert	42	Steptoe
8	Independence	43	Honey Lake, Warm Springs, Newcomb Lake, Cold Spring, Dry, Lemmon, Red Rock, Spanish Springs, Bedell Flat, Sun, and Antelope
9	Gabbs	44	Smoke Creek Desert, San Emidio, Desert, Pilgrim Flat, Painters Flat, Skedaddle Creek, Dry (near Sand Pass), and Sano
10	Sarcobatus and Oasis	45	Clayton, Stonewall Flat, Alkali Spring, Oriental Wash, Lida, and Grapevine Canyon
11	Hualapai Flat	46	Mesquite, Ivanpah, Jean Lake, and Hidden
12	Ralston and Stone Cabin	47	Thousand Springs and Grouse Creek
13	Cave	48	Little Owyhee River, South Fork Owyhee River, Independence, Owyhee River, Bruneau River, Jarbidge River, Salmon Falls Creek, and Goose Creek
14	Amargosa Desert, Mercury, Rock, Fortymile Canyon, Crater Flat, and Oasis	49	Butte
15	Sage Hen, Guano, Swan Lake, Massacre Lake, Long, Macy Flat, Coleman, Mosquito, Warner, Surprise, and Boulder	50	Lower Moapa, Black Mountains, Garnet, Garnet, Hidden, California Wash, Gold Butte, and Greasewood
16	Dry Lake and Delamar	51	Virgin River, Tule Desert, and Escalante Desert
17	Duck Lake	52	Columbus, Rhodes, Teels, Adobe, Alkali, Alkali, Garfield Flat, Huntton, Mono, Monte Cristo, Queen, Soda Spring
18	Garden and Coal	53	Antelope, East Walker area
19	Middle Reese and Antelope	54	Cactus Flat, Gold Flat, Kawich, Yucca Flat, Frenchman Flat, Papoose Lake, Groom Lake, Tikapoo, Three Lake, Indian Springs, Las Vegas, Buckboard Mesa, Mercury, Rock, Jackass Flat, Crater Flat
20	Black Rock Desert, Granite Basin, High Rock Lake, Mud Meadow, and Summit Lake	55	Granite Springs, Kumiva, Fireball, Bradys Hot Spring areas
21	Pahranagat and Pahroc	56	Pilot Creek Valley area, Elko and White Pine Counties
22	Pueblo, Continental Lake, Virgin, and Gridley Lake	57	Truckee River
23	Dixie, Stingaree, Fairview, Pleasant, Eastgate, Jersey, and Cowkick	58	Fish Lake Valley, Nevada and California
24	Lake	59	Carson River basin, western Nevada
25	Coyote Spring, Kane Springs, and Muddy River Springs	60	Railroad and Penoyer Valleys, east-central Nevada
26	Edwards Creek		
27	Lower Meadow, Patterson, Spring (near Panaca), Rose, Panaca, Eagle, Clover, and Dry		
28	Smith Creek and Ione		
29	Grass (near Winnemucca)		
30	Monitor, Antelope, Kobeh, and Stevens Basin		
31	Upper Reese		
32	Lovelock		
33	Spring (near Ely)		
34	Snake, Hamlin, Antelope, and Pleasant		
35	South Fork, Huntington, and Dixie Creek-Tenmile Creek		

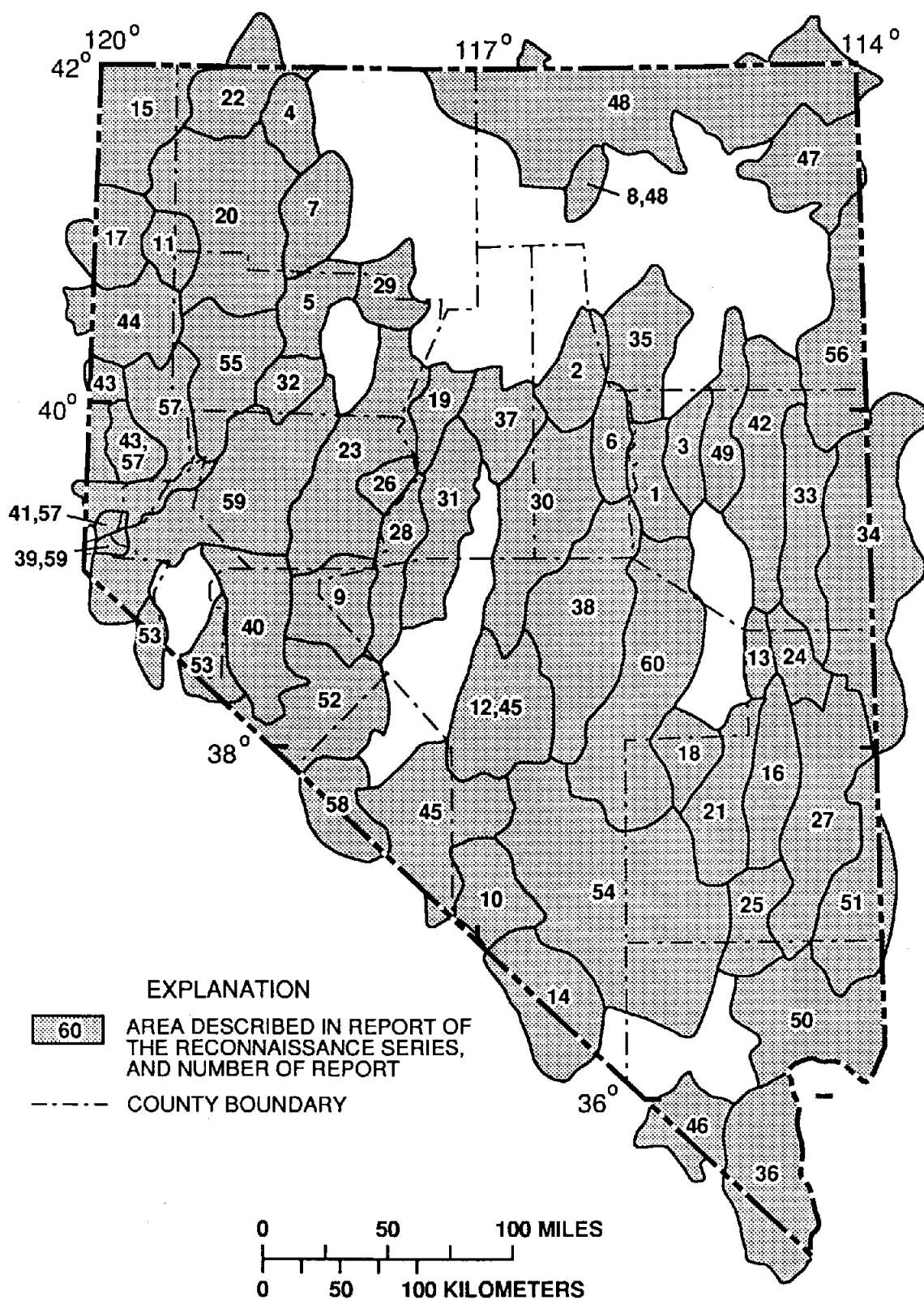


FIGURE 2.--Areas described in reports of the "Nevada Water-Resources Reconnaissance" series.

In addition to the Nevada Water Resources Bulletins, Reconnaissance Reports, and Information Reports, the geologists and engineers of the U.S. Geological Survey have contributed additional reports, such as U.S. Geological Survey Professional Papers and Water-Supply Papers published by the Government Printing Office in Washington, D.C. Other papers bearing on ground-water studies in Nevada have been prepared for water journals and other publication media.

Much has been learned about the ground-water resources of Nevada since 1938 when Penn Livingston, U.S. Geological Survey engineer, conducted leakage tests on a number of wells in the Las Vegas Valley. Other highlights include the start of a detailed study of the ground-water resources of the Las Vegas Valley artesian basin in 1945 conducted by George B. Maxey, Assistant Geologist, U.S. Geological Survey, and Harry Jameson, and the start of the statewide ground-water program in 1945 that resulted in an inventory of the ground-water resources of Nevada. The author was intimately associated with the U.S. Geological Survey ground-water studies in Nevada, first as Assistant State Engineer, then as State Engineer, and finally as Director of the Department of Conservation and Natural Resources from 1957 to 1965.

CONCLUSION

As initially contemplated, the author intended to limit the subject matter to the evolution of the water laws of Nevada. With the approval of Nevada District Chief Terry Katzer of the U.S. Geological Survey, other related activities were covered, such as the problems confronting the early State Engineers, starting with A.E. Chandler in 1903, as chronicled in the biennial reports of the State Engineer; the beginning of the underground water studies and the 1939 Underground Water Act; the Las Vegas Valley ground-water studies leading up to the statewide program; establishment of a U.S. Geological Survey, Nevada District Office in Carson City, July 1, 1945, with Thomas W. Robinson as district engineer; and the extensive ground-water studies conducted by the U.S. Geological Survey between 1942 and the present.

Consequently, descriptive material was prepared concerning the cooperation between the U.S. Geological Survey and the State of Nevada in the stream-gaging program, which started in 1901 and, with the exception of a few years between 1908 and 1913, has been continuous to this day (1990). In 1947, a Surface Water Branch office was established in 1947 with L.R. "Tom" Sawyer as engineer in charge.

The cooperative program was greatly enhanced when the Geological Survey created a Water Resources Division Office in Nevada, July 1, 1962, with George F. Worts, Jr., as District Chief. This was the first consolidated Water Resources Division State office combining ground-water and surface-water activities in the United States. Its worth has been well proven by the progress made in Nevada.

APPENDIX 1

HUMBOLDT RIVER RESEARCH PROJECT

The Humboldt River Research Project was authorized by the Nevada State Legislature in 1959 (Chapter 97, Statutes of 1959). The legislature gave the Department of Conservation and Natural Resources \$35,000 to start the program in 1959 and increased this amount to \$40,000 for 1960.

The major objectives of the study were to evaluate water resources of a segment of the Humboldt River Valley in the vicinity of Winnemucca as thoroughly as possible, and thus provide information that would be helpful in planning for the most effective use of these resources not only in the study area but also applying the results to similar areas in the State. The Nevada Department of Conservation and Natural Resources was authorized to coordinate the work of the participating Federal and State agencies. The author, as Director of the Department, named Assistant Director George Hardman as the project coordinator for the State.

A distinguishing feature of the Humboldt River Research Project was the large number of cooperating agencies and the promptness with which reports on the numerous individual studies were prepared. The following agencies, State and Federal, participated in the project:

Nevada Department of Conservation and Natural Resources
Division of Water Resources
Division of Forestry

University of Nevada, Reno
Nevada Bureau of Mines
Department of Geology
Desert Research Institute

U.S. Geological Survey
Ground Water Branch
Surface Water Branch
General Hydrology Branch

U.S. Agricultural Research Service
U.S. Bureau of Reclamation
U.S. Soil Conservation Service
U.S. Weather Bureau
U.S. Bureau of Land Management
University of Illinois, Department of Geology
Southern Pacific Railroad

Although the legislation authorized the project for the Humboldt River without designating any particular section, it was decided by the several agencies that the funds available would be insufficient to cover the entire Humboldt River Basin and that it would be better to limit the work to a relative small segment of the basin. It was decided that the Winnemucca section offered a favorable setting for this study.

The Winnemucca reach of the Humboldt River Valley includes part of the valley between the Comus gaging station at the upper end of the area and the Rose Creek gaging station at the lower end of the area. The Comus station is about 22 miles east (upstream) and the Rose Creek station 15 miles southwest (downstream) of Winnemucca, a straight-line distance of 37 miles. The meandering course of the river is about twice this distance.

This stretch of the Humboldt River basin furnishes almost any condition that would be encountered in the basin as a whole. There were good streamflow records at both Rose Creek and Comus gaging stations.

As indicated earlier, the project is made up of a series of studies conducted by the several cooperating Federal and State agencies. Each cooperating agency carried on its work independently, but each study was designed as a vital component of the comprehensive program. The Nevada Department of Conservation and Natural Resources carried on little work independent of the cooperating agencies, but used its State funds and personal services to supplement the funds of the several agencies, and in addition served to coordinate activities of the other agencies.

As previously noted, a principal objective of the Humboldt River Research Project was to determine the disposition of water resources within the study area; in other words, to evaluate various components of the hydrologic cycle that are operative within the study area. This activity largely involved the work of the several branches of the Water Resources Division, U.S. Geological Survey.

The U.S. Geological Survey commenced its research studies in 1959 under the direct supervision of O.J. Loeltz, District Engineer of the Ground Water Branch of the U.S. Geological Survey in charge of ground-water studies in Nevada. With the establishment of a Water Resources Division office in Carson City during 1962, George F. Worts, Jr., District Chief in charge of hydrologic investigations in Nevada, took over the supervisory work. The interpretive ground-water studies were made by Philip Cohen, geologist. R.L. Hanson was in charge of the surface-water studies, and Thomas W. Robinson, headed the section on general hydrology, concerned with the use of water by phreatophytes.

It is not the intention of the author to present in detail the work performed by the several agencies, but rather to summarize the work in order to give the reader some idea of the magnitude of the project. As the project advanced from 1959 to 1969, annual progress reports were submitted by the Nevada Department of Conservation and Natural Resources.

Briefly, the work of the several agencies is herewith summarized.

U.S. Geological Survey

Ground Water Branch

The objectives of the work done by the Ground Water Branch were to determine (1) seasonal and long-term changes of ground water in storage, (2) the relation between the Humboldt River and the ground-water reservoir, (3) ground-water underflow into and out of the study area, and (4) the chemical quality of the waters of the area. The work of the Ground Water Branch was characterized by a number of reports authored by Philip Cohen.

The results of this study were set forth in a 1964 report titled: *Preliminary Results of Hydrogeologic Investigations in the Valley of the Humboldt River Near Winnemucca, Nevada*: U.S. Geological Survey Water-Supply Paper 1754, Nevada Department of Conservation and Natural Resources, Water Resources Bulletin 22.

Surface Water Branch

The surface-water investigations included measurements of flow in the Humboldt River within the reach between Comus and Rose Creek gaging stations and estimation of the inflow to the river from tributary streams. Complete evaluation of the surface-water movement included measurement of all water entering the area, diversions for irrigation and other uses, measurement of all return flows, determination of ditch and canal losses, and measurement of surface outflow from the area at the Rose Creek gaging station.

Quality of Water Branch

The quality of water program was included in the Ground Water Branch program. The results of this work were reported on by Philip Cohen in Water Resources Bulletin 19, Nevada Department of Conservation and Natural Resources.

General Hydrology Branch

Work of the General Hydrology Branch pertained to evapotranspiration studies of native vegetation. The studies were centered in a small tract of land about 3 miles southwest of Winnemucca. From the beginning of the project in 1959 to April 1968, the technical phases of the evapotranspiration work with woody phreatophytes were supervised by Thomas Robinson. (Mr. Robinson retired in April 1968 and was replaced by Otto M. Gross.) The U.S. Bureau of Reclamation participated in the funding and installation of the lysimeter tanks.

While the field studies of other Water Resources Branches were mainly completed in 1962, the evapotranspiration studies continued for several years. The Fourth Progress Report, April 1969, was a detailed report by Otto M. Gross.

Nevada Bureau of Mines, Desert Research Institute, University of Illinois, Department of Geology

The basic work on the geology and geomorphology of the area was carried on as a joint undertaking by the Bureau of Mines of the University of Nevada and the Geology Department of the University of Illinois. The field work was conducted by graduate students from both schools. Much additional geological information of great importance to the overall program was collected during the progress of the test drilling for the hydrology program for the U.S. Geological Survey.

The Desert Research Institute contributed to the research project using a portion of the funds from an appropriation of \$25,000 to be expended on ground-water research in cooperation with the Nevada Department of Conservation and Natural Resources. The work of the Desert Research Institute was under the supervision of Dr. George Burke Maxey, Research Professor of Hydrology and Geology, University of Nevada, Reno.¹

The geological and geophysical studies of the Humboldt project were conducted by the Desert Research Institute, and the field work was done by five of Dr. Maxey's graduate students from the University of Illinois and one graduate student from the University of Nevada. These students were John D. Bredehoeft, John W. Hawley, William E. Wilson, Lyle D. McGinnis, and William W. Dudley, Jr., from the University of Illinois and Keros Cartwright, University of Nevada, Reno.

U.S. Agricultural Research Service

The study by the U.S. Agricultural Research Service was to (1) measure the evapotranspiration of three types of meadow vegetation, principally grasses; (2) measure climatic factors; (3) relate climatic measurements to evapotranspiration; and (4) determine the evapotranspiration of meadow vegetation in the study area under various water table and climatic conditions, based on lysimeter data.

U.S. Soil Conservation Service

A standard soil survey of the Winnemucca area, which included mapping the extent and density of phreatophytes, was made by the U.S. Soil Conservation Service. From the beginning of the Humboldt River Research Project, the Nevada Department of Conservation and Natural Resources believed that a comprehensive study of the resources of the entire river basin would be needed. This need was met by the Humboldt River Basin Survey, under section 6 of Public Law 566, which started in 1960. The Humboldt River Basin Survey was a cooperative program between the U.S. Department of Agriculture and the Nevada Department of Conservation and Natural Resources, and the work was carried on under the general supervision of C.H. Cleary, Jr., State Conservationist of the Soil Conservation Service. The Humboldt River Basin was divided into 11 subbasins. The land and water resources of each subbasin were appraised and reported in a series of 11 reports. The final report, number 12, date November 1966, is a summary of information from the 11 basin reports.

¹ Burke Maxey came to Nevada in 1944 as a geologist with the U.S. Geological Survey to conduct ground-water studies in the Las Vegas Valley. In 1946, he was transferred to Ely, Nev., where he worked with Thomas E. Eakin, also a geologist with the U.S. Geological Survey, on ground-water investigations in the eastern part of Nevada. In 1948, Dr. Maxey left Nevada to complete his studies at the University of Connecticut and Princeton University. In 1955, he became Professor of Geology, University of Illinois, and head of the section on ground water. In 1962, he returned to Nevada to join the staff of the Desert Research Institute and the University of Nevada, as Research Professor of Hydrology and Geology.

Reports

During the course of the studies on the Humboldt River Research Project, 10 reports were issued by the Nevada Department of Conservation and Natural Resources spanning the years 1960-69. The results of the 5-year study of water in the Winnemucca area were summarized by Philip Cohen and printed as U.S. Geological Survey Water-Supply Paper 1754.

In 1966, a report titled, *Hydrologic Reconnaissance of the Humboldt River Basin, Nevada*, was issued. The authors were Thomas E. Eakin, Robert D. Lamke, and Duane E. Everett. This report was printed as Water Resources Bulletin 32 by the Nevada Department of Conservation and Natural Resources and covers all the hydrologic data available at that time on the Humboldt River stream system.

APPENDIX 2

NEVADA LAND GRANTS

During the first two decades following the organization of the Territory of Nevada on March 2, 1861, several land grants were made by the Federal Government. These grants were:

<u>Grants</u> ¹	<u>Acreage</u>	<u>Date of Grant</u>
Indemnity (Live Lands)	9,229	Feb. 26, 1859
Internal Improvements	500,000	Mar. 21, 1864
Mining and Mechanics Arts College	90,000	July 2, 1862
University	46,080	July 4, 1866
Public Buildings	12,800	Mar. 21, 1864
State Prison	12,800	Mar. 21, 1864
The 2,000,000 Acre-In-Lieu	2,000,000	June 16, 1880
Sixteenth and Thirty-Six Sections	63,249	Mar. 21, 1864
Total	<u>2,734,158</u> acres	

The total acreage of land grants varied over the years. The early records of the surveyor general show the total grants to be 2,732,884 acres whereas the *Public Land Statistics*, 1967, issued by the U.S. Bureau of Land Management, shows the grants to be as follows:

Common Schools	2,061,967 acres
Other Schools	136,080
Other Institutions	12,800
Misc. Improvements	500,440
Other Purposes	14,379
	<u>2,725,666</u> acres

The 16th and 36th Acre Grant remained in effect until June 16, 1880, when the 2 million acres In-Lieu Grant was approved by Congress. The reason for the change, as explained by Surveyor General E.D. Kelley in his 1905-06 Biennial Report, was based on the grounds that as Nevada was a mountainous state, a great portion of the 16th and 36th sections of land would be on lands unsuitable for agricultural purposes. So at the urging of the Nevada Congressional delegates, Congress provided that in lieu thereof the State could select 2 million acres of unreserved public lands. The congressional act was conditioned upon the State of Nevada surrendering to the United States of all 16th and 36th sections of land undisposed of by June 16, 1880. Between March 21, 1864, and June 16, 1880, the State had selected and sold 63,249 acres.

During the period the 16th and 36th grant was operative, some selections were made on unsurveyed lands later found to be out of place. On such lands Congress provided the Indemnity or "Lieu" Grant which allowed the land owners to select other lands of equal worth. Some 9,229 acres were granted under this provision.

¹ Surveyor General's Biennial Report, 1929-30.

The proceeds received from the sales of lands obtained under the 16th and 36th sections, Indemnity, Internal Improvements, and the 2-Million-Acre grants were used for the support of the common schools. The proceeds received for the sale of lands obtained under each of the other grants were used for the support of the purpose indicated by the name of the grant.¹

It was noted in the Surveyor General Biennial Report for the years 1905-06 that under the 16th and 36th Acre Grant the State would have been eligible to receive about 3,992,000 acres. So by choosing the 2-Million-Acre Grant the State lost 1,992,000 acres. However, the choice gave the State the advantage of selecting any unappropriated public lands, whether or not in the 16th or 36th sections. The greater part of the 3,992,000 acres would have been situated in the mountains and other areas where the land would not be suitable for agricultural purpose. Whether the State gained or lost by accepting the 1886 In-Lieu Grant is not known. It should be kept in mind that all the more usable lands in the State would have eventually been taken up under the Desert, Homestead, and other acts of Congress. From the viewpoint of management of the unappropriated lands by the Federal government, the State made the right move.

The 1901-02 Biennial Report of the surveyor general listed the total acreage selected by the State and approved by the United States Land Office under the 2-Million-Acre Grant from June 16, 1880 to 1902, inclusive. It has heretofore been stated that during the life of the 16th and 36th Acre Grant (March 21, 1864 to June 16, 1880), only 63,249 acres had been purchased. For the years 1880-82, under the 2-Million-Acre Grant, 167,946 acres had been acquired by the State and sold to settlers. The big years of land purchase were from 1885 through 1889, when 1,123,442 acres were purchased.

By the year 1900, there had been 2,011,044 acres selected by the State under the 2-Million-Acre Grant. During the same year the total land granted to the State, under the various grants, was 2,690,683 acres.²

It seems that shortly after the turn of the century the surveyor general and state land register refused to accept any applications for selection, as all the land available had been selected. However, over the years, many thousand acres of land reverted to the State for failure of the purchaser to pay the interest owed or by withdrawal. For instance, in the 1909-10 report of the surveyor general, it was reported that up to January 1, 1911, more than 900,000 acres had been forfeited under all the grants. These lands were referred to as reverted lands. Such lands were often reapplied for, and the process of reversion and re-appropriation continued until recent years.

Under the State land laws the applicant to lands under the 2-million-acre grant was limited to 640 acres, and under other grants to only 320 acres. The State was to receive \$1.25 per acre for lands selected under the 2-million-acre grant and \$2.50 per acre if within 20 miles of the Central Pacific Railroad and selected under the old grants. The terms were 20 percent cash with application, the balance in 20 years at 6 percent per annum interest, though the option was given the purchaser of making full payment at any time.³ The total acreage of land grants in Nevada, as of 1960, amounted to 2,725,666 acres.⁴

¹ Surveyor General's Biennial Report, 1929-30, p. 9.

² Surveyor General's Biennial Report, 1899-1900.

³ Surveyor General's Biennial Report, 1905-06.

⁴ U.S. Bureau of Land Management, 1968, Public land statistics, 1967: U.S. Department of the Interior, Bureau of Land Management, table 4.

Railroad Grant

To aid the Central Pacific Railroad during its eastward construction across Nevada Territory, the Federal Government, in 1862 and 1864, made liberal grants of land to the railroad company (which is now known as the Southern Pacific Transportation Co.). The granted lands consisted of alternate (odd numbered) sections for 20 miles north and south of the center of the track. As of 1967, the railroad grant amounted to 5,086,603 acres.¹ Patents to such lands could not be granted until the United States surveys had been completed. In Nevada the major survey work had been done during 1881-82. By that time the Central Pacific had secured patents to less than one-eighth of the total lands contained in the grants. As long as the land was not patented to the company, it could not be taxed. As a result, a large number of the railroad sections were not taxable while adjoining sections that had passed into private ownership had to bear a greater portion of the support of the State and local governments.²

The total land grants by the Federal Government to the State of Nevada were:

Grants to State	2,725,666 acres
Railroad grant	5,086,604
Total	<hr/> 7,812,270 acres

¹ U.S. Bureau of Land Management, 1968, Public land statistics, 1967: U.S. Department of the Interior, Bureau of Land Management, tables 5 and 6.

² Scrugham, James G., ed., 1935, Nevada--A narrative of the conquest of a frontier land: American Historical Society, v. 1, p. 314.

Statistical Data Regarding Ownership of Land

Land area	70,264,320 acres or	109,788 square miles
Inland water area	481,280	752
Totals	<u>70,745,600 acres</u>	^a <u>110,540 square miles</u>
Land area in Nevada	70,264,320 acres	
Land area owned by Fed. Govt.	60,971,262	
Land area not owned by Govt.	<u>9,293,058 acres</u>	
Percent of land owned by Govt.	^b 86.774	

The makeup of the 9,293,058 acres of land not owned by the Federal Government is about as follows:

Total area of land not owned by Federal Government		9,293,058 acres
Land grants to State	2,725,666 acres	
Railroad grants	5,086,604	
Total land grants	<u>7,812,270 acres</u>	<u>7,812,270</u>
Land (other than grants) not owned by Fed. Govt.		<u>1,480,788 acres</u>

Other acquisitions from Federal Government (approx.)

Desert land patents	^c 319,630 acres
Stock-raising homesteads	^d 494,637
Mineral patents	^e 294,916
Others including homesteads, small tracts, public auction sale	371,603
Total	<u>1,480,788 acres</u>

^a U.S. Bureau of Land Management, 1968, Public land statistics, 1967: U.S. Department of the Interior, Bureau of Land Management, table 1 (as of 1960).

^b Ibid., table 7 (as of 1966). This 86,774 percent figure will decrease slightly as Federal lands are transferred or sold.

^c Ibid., table 26 (from March 3, 1877, to June 30, 1967).

^d Ibid., table 27 (from 1917-67).

^e Ibid., table 18 (through 1967).

**Federal Lands Under Jurisdiction of
Federal Agencies in Nevada, June 30, 1966^a**

U.S. Department of the Interior	
Bureau of Land Management	47,749,645 acres
National Park Service	115,880
Bureau of Reclamation	1,160,812
Fish and Wildlife Service	2,909,033
Bureau of Indian Affairs	7,812
Other	23
U.S. Department of Agriculture	
Forest Service	5,059,462
U.S. Department of Defense	
Department of Air Force	2,929,186
Department of Army	7,167
Army Corps of Engineers	1,020
Department of Navy	212,051
U.S. Atomic Energy Commission (now Dept. of Energy)	817,019
Other Civil Services	2,153
Total	<hr/> 60,971,263 acres
From Public Domain	60,812,024
Acquired Lands	<hr/> 159,239 acres

^a Ibid., table 10 (as of June 30, 1966).

APPENDIX 3

THE CAREY ACT

On August 18, 1894, Congress approved what was commonly called the "Carey Act." It was expected to be a major milepost in reclamation of desert lands. The purpose of the law was to aid the public-land states in reclamation of desert lands, and provide for granting to each of the states containing desert lands an amount not exceeding 1 million acres and direct that the states cause it to be reclaimed, occupied, and irrigated. It was further provided that 20 acres out of each 160 acres be cultivated by settlers within 10 years after passage of the act.

The acts of the Nevada State Legislature approved March 8, 1897, and March 6, 1901, sought to make the Carey Act effective in Nevada. However, not until the act of the legislature was approved March 23, 1909 (Chapter 164), was anything accomplished in the efforts of the State. Promoters of the Carey Act projects urged the State to secure the land reservations contemplated in the Carey Act of Congress. After the act of the legislature was approved March 23, 1909, the Carey Act came into practical operation in Nevada and made possible the selection of large tracts of land by promoters for reclamation and settlement.

Another State act pertaining to Carey Act land acquisition went into effect March 17, 1911. Under this act a department of the State Commission of Industry, Agriculture, and Irrigation was established, known as the "Department of Carey Act Lands." Also, under this act the Nevada surveyor general was designated as "State Register of Lands under the Carey Act," and was in general charge of said department, subject to supervision and control of the Commission. The State Engineer was designated as the "selecting agent" for the State to determine and make affidavits as to the desert character of land and water resources as required by the U.S. General Land Office (incorporated into Bureau of Land Management in 1946).

The main purpose of the Federal Carey Act laws was to aid the western public-land states in obtaining the reclamation and settlement of their desert lands. This was done by making it possible for such states, or for private industry under State supervision, to promote and construct irrigation and reclamation projects as necessary to deliver sufficient water on such lands to successfully irrigate and reclaim the same. A great number of reclamation projects were proposed in almost every part of the State, instituted under the provisions of the Carey Act. In almost all cases proposals were by promoters, but lack of "water supply" proved to be one of the major obstacles. Lacking an adequate water supply, the promoters were unable to raise necessary funds to construct irrigation works necessary to get water to the land to be reclaimed.

The State act of 1909 did not provide a filing fee nor a price for the lands; consequently, large tracts of land were covered by applications for speculative purposes, so much so that the original grant of 1 million acres became exhausted. Congress granted to Nevada, by an act approved March 4, 1911, an additional 1 million acres. Following the passage of the State act of March 17, 1911, a filing fee of 1 cent per acre plus other fees reduced the total number of applications considerably.

In approving the Carey Act, Congress made it possible for private enterprises to furnish water for reclamation purposes on irrigable lands that could not be accomplished by individual undertakings. However, with a few exceptions, the Carey Act did not measure up to expectations.

In general, the steps required to conform to the Carey Act were as follows, although they varied somewhat according to the laws of each State: An applicant was required to file a map showing the lands to be irrigated, the source of water, and the plan of irrigation. When the plans were approved, the lands were considered as being segregated, and the United States reserved them from other entry, pending disposal by the State. The States were then authorized to enter into contracts for the physical reclamation of the land. Such lands were patented to the States, which in turn could sell to individuals who had contracted with the applicant to purchase water rights.

Up to June 30, 1949, a total of 35,809 acres of land had been segregated in the State of Nevada. Of this amount, State patent had been issued for only 1,579 acres, which was irrigated from the waters of Bishop Creek, a tributary of the Humboldt River in Elko County.

Up to the year 1969, a total of 1,075,246 acres had been patented under the Carey Act in the 10 western public-land states. On the whole, the Carey Act was considered a failure. Only two states had some success. In Idaho, the government granted patents to the State for 629,724 acres, and in Wyoming, 198,531 acres were patented.¹ The states then issued patents to settlers who had contracted for water from the companies who developed the water and canal projects. Each State had developed its own procedures as to the cost of land and other fees.

As earlier mentioned, only 1,579 acres of land had been patented to Nevada, the entire acreage contained in one project promoted by the Pacific Reclamation Company. Of the land patented to the State by 1930, only 526 acres had been patented to the settlers up to that time.² A more detailed description of this project and its satellite town of Metropolis is discussed later in this section. The Nevada State Legislature approved an act March 23, 1909, which made it possible for the State to proceed under the Federal Carey Act legislation of March 15, 1910, which spelled out in detail the requirements of the State relative to the available water supply required for the land to be patented to the State. The amendment to the Carey Act of March 15, 1910, read in part as follows:

"... that all of the forms and conditions imposed by the state law upon such proposer prior to segregation have been complied with; that from the showing made by the proposer (or state other source of information) it is believed that sufficient water to irrigate the whole of the lands asked to be withdrawn, over and above prior appropriations, is available; and that the proposer has either acquired title to such water or applied for same, and that the lands are desert in character." [Emphasis added]

The State Act of March 17, 1911, added some additional amendments, among which were actions that must be taken by the State Engineer relative to the sufficiency of a water supply, as required by federal regulations. In part the State language read:

"Such application shall be prepared and submitted in accordance with such rules and regulations as the Commission may adopt and prescribe, and which shall be in conformity with any rules and regulations of the Department of the Interior, and shall be accompanied by the certificate of the State Engineer that application for permit to appropriate water therefor has been filed in his office."

¹ Galze, Alfred R., 1952, Reclamation in the United States: p. 11.

² Surveyor General's Biennial Report, 1929-30, p. 7.

The legislation also required the State Engineer not only be concerned with the water supply but also must submit a written report as to the feasibility of the project, status of water rights, and other data necessary to enable the state register of lands under the Carey Act to make proper certification required by the General Land Office.

During April 1911, State Engineer William Kearney prepared a ruling approved by the State Commission of Industry, Agriculture and Irrigation, applying to the procedure in making application to appropriate underground water for a Carey Act project. This set of rules can be found in the 1911-12 Biennial Report of the State Engineer, but it was not until 2 years later that the 1913 General Water Law was enacted that prescribed "the water of all sources of water supply within the boundaries of the State, whether above or beneath the surface of the ground, belongs to the public and subject to existing rights, may be appropriated as provided in the chapter and not otherwise." Thus, the 1911 legislation seemingly was intended to apply only to underground water to be used under the provisions prescribed in the Carey Act.

Early Carey Act Land Applications

The first application filed for a Carey Act project, following the 1909 State legislation, was made October 21, 1909, by the Pacific Reclamation Company for the segregation of 10,281 acres of land situated in Bishop Creek Valley in Elko County, Nev. Seven other applications were filed during 1909, six in the Las Vegas Valley in Clark County and one in Amargosa Valley in Nye County. Five applications in the Las Vegas Valley were subsequently relinquished. The application of the Amargosa Valley Land and Irrigation Company was approved but later relinquished. Of the eight applications noted, only the Pacific Reclamation Company and the Las Vegas Irrigated Fruit Land Company, following approval, prepared plans and started preliminary work. The Las Vegas Irrigation Fruit Land Company drilled four wells in the south tier of sections in T. 21 S., R. 61 E., about 6 miles directly south of Las Vegas. According to the tabulation of County Surveyor J.T. McWilliams, the wells ranged between 355 and 550 feet in depth, all having small artesian flows.¹ This application was later relinquished, no doubt due to lack of financial backing and the failure of the wells to produce larger artesian flows.

The Pacific Reclamation Company

The only Carey Act project that was partially carried to completion in Nevada was that of the Pacific Reclamation Company. The application filed October 21, 1909, was for the segregation of 10,281 acres of land in Bishop Creek Valley, Elko County, Nev. The land was situated in parts of T. 38 and 39 N., R. 61 E., and T. 39 N., R. 62 E. The application was approved June 17, 1910, for 9,706 acres.² The total area contemplated to be supplied with water was 25,000 acres, of which about 15,000 acres was owned privately by the company, having been purchased from the Central Pacific Railway Company, and comprised the odd-numbered sections (see chapter on Railroad Grant).

Unlike practically all the other Carey Act filings, this company consisted of eastern capitalists who were apparently well financed and equipped to run a large reclamation project. The Pacific Reclamation Company had two ancillary companies, the Metropolis Land Company to handle the disposal of the land and the Metropolis Improvement Company designed to develop the town of Metropolis, a company undertaking.

¹ This tabulation appears in the 1911-12 Biennial Report of the State Engineer (p. 250-251), which describes 95 wells that had been drilled in the Las Vegas Valley by 1912.

² Surveyor General's Biennial Report, 1913-14.

The Pacific Reclamation Company was sincere in bringing this project to fulfillment as shown by the rapidity of its operation during 1911 and 1912. Starting in 1911, a \$200,000 dam was constructed on Bishop Creek, designed to store 30,000 acre-feet of water. A concrete diversion dam was built downstream from the dam, and the construction of a canal system commenced. The town of Metropolis included graded streets, a large three-story hotel, schools, other business buildings, a newspaper (the "Metropolis Chronicle") owned by the company. A 6-mile branch railroad spur from the main tracks of the Southern Pacific at Tulasco, about 6 miles west of Wells, started operation October 1911. A railway station was completed in Metropolis, March 1912. All these events, and many others, occurred during the short period of 2 years. By the end of 1912, Metropolis was a thriving town with several hundred residents and many comfortable homes.

Under the provisions of the Carey Act the only money the company could make from the Carey Act lands was for the sale of water to the farmers. However, the major source of revenue in this undertaking came from the sale of privately owned land to the new settlers. It has been reported that some of the land sold for \$300 per acre. The land was situated in a checker-board fashion, the odd-number sections being company land and the even numbered sections Carey Act land.

In studying the history of this project the reader could come to the conclusion that the company might have been more interested in designing its canal system to reach the best company lands. Then too, the farmers who were developing the private lands would also have to pay for the use of water furnished by the company.

Bishop Creek Dam

The major facility of the project was a \$200,000 dam on Bishop Creek which was designed to form a 30,000-acre-foot reservoir. The location of the dam was about 10 miles north of Wells, Nev., and 8 miles directly east of the town of Metropolis. Bids for the construction closed April 15, 1911, and the dam was completed during May 1912. The dam was of the earth-fill type with a rubble facing on the upstream side which was lined with reinforced concrete. A reinforced concrete conduit was constructed through the base of the dam and was provided with suitable gates regulated from a tower. After being discharged from the dam the water flowed down the natural channels about 3 miles to a diversion dam.¹ It is noteworthy that the dam still stands after over 70 years of life and has survived several flood periods, the latest being in 1984.

Branch Railroad to Metropolis

A spur railroad, about 6 miles in length, was constructed by the Southern Pacific Railroad. The connection was made at Tulasco, a station on the main line about 6 miles west of Wells. Rail service to Metropolis started during October 1911 and passenger service to Wells started February 1912. A well appointed railroad station was completed at Metropolis by March 1912. Daily runs from Wells and return were continued until September 1913, when the dwindling business of the town caused the railroad to reduce the runs to tri-weekly. By 1916, the runs had been reduced to one trip per week. The U.S. Interstate Commerce Commission authorized the Southern Pacific to abandon the Metropolis branch in August 1922, but the line was operated intermittently until it was dismantled, August 1925.

¹ State Engineer's Biennial Report, 1911-12.

The story of the Pacific Reclamation Company and the town of Metropolis was well documented by Victor O. Goodwin, a noted writer of Nevada history. Much of the data herein pertaining to all phases of the Pacific Reclamation Company project were taken from Mr. Goodwin's findings.¹

The Story of Metropolis

The rapid growth of the town of Metropolis has already been mentioned. A few added details are described here. The crowning event which paved the way for the rapid progress made by the Metropolis Improvement Company was the construction of the three-story Metropolis Hotel. This hotel, built at a cost of \$100,000, was at that period one of the finest hostleries in Nevada. Elevators served all floors, and the appointments were outstanding. The Metropolis Bank was on the first floor. An electric generator was installed in the basement.

The first school in Metropolis was a two-room structure completed in January 1912. Sixty pupils were attending classes by the following February. During February 1912 a \$25,000 brick and stone school building was being constructed which replaced the two-room schoolhouse.

A water system, originating from springs in Trout Canyon, was completed by March 1912. A water pressure of 85 to 105 pounds per square inch was maintained in the lines which more than adequately served the water needs of the town.

It was reported that an electric power plant, whose turbines were to generate electricity from water piped to the townsite in a large steel pipe from lower Trout Creek, was projected but was not built prior to the collapse of the project.

During 1911, the Metropolis Chronicle, a company owned newspaper, started publication and was the local voice of the Pacific Reclamation Project Company until it was terminated April 1913.

A post office served Metropolis from November 24, 1911, to December 10, 1942, after which all mail was sent to Wells.

¹ A number of subbasin reports were prepared for the Humboldt, Walker, Carson, and Truckee river basins by a field party consisting of personnel from the U.S. Forest Service, U.S. Soil Conservation Service, and U.S. Agricultural Research Service in cooperation with the Nevada Department of Conservation and Natural Resources. Mr. Goodwin represented the U.S. Forest Service. As a prelude to each subbasin report, Mr. Goodwin documented the early history of the area being studied. Following the completion of the 11 subbasin reports on the Humboldt River, Mr. Goodwin authored a more detailed history of each of the 11 subbasins. The story of the Pacific Reclamation Company was contained in the history of the Mary's River subbasin. The title of this historical work was *The Humboldt-Nevada, Desert River, and Thoroughfare of the American West*, by Victor O. Goodwin, U.S. Department of Agriculture--Nevada Humboldt River Basin Survey, 1966. Only 25 copies of this work were printed.

Unfortunate End of the Pacific Reclamation Company

The Pacific Reclamation Company in inaugurating this well-planned reclamation project, believed that the waters of Bishop, Burnt, and Trout Creeks could furnish sufficient water for the irrigation of all 25,000 acres. The construction of the \$200,000 dam on Bishop Creek was the first step. However, legal trouble started in early 1912 when the water users in the Lovelock Valley instituted a lawsuit against the Pacific Reclamation Company, enjoining the company from making full use of the water of Bishop, Trout, and Burnt Creeks. As a result, the company was limited to the use of water on only 4,000 acres. This meant the end of the project. The Pacific Reclamation Company and the Metropolis Land Company went into receivership in April 1913. By 1920, all divisions of the Pacific Reclamation Company were declared bankrupt.

This was the end of a practical and well-intentioned reclamation project. The town rapidly deteriorated. The hotel, which closed its doors during 1913, and the brick school building were either burned or demolished. Other buildings were moved away, and the depot was demolished or dismantled. All that remains now are remnants of foundations, largely covered by sagebrush.

The rise and fall of the town of Metropolis was reminiscent of the rise and fall of many mining camps in Nevada. As Victor Goodwin so aptly stated, "Metropolis is the only ghost agricultural town in Nevada." In the case of a boom mining camp, its life ended when the ore played out. In this instance it could be said that lack of a water supply brought about the downfall of Metropolis.

Following the collapse of the Pacific Reclamation Company and its supporting companies, a number of farmers remained--some no doubt using available Bishop Creek water and others trying to dry farm. By 1924, according to Mr. Goodwin, about 200 persons were still in the area. However, the drought and depression of the 1930's brought almost all farming activity to an end.

Legislation pertaining to the participation by the State under the Carey Act still remains in force.

OTHER EARLY FEDERAL LAND LEGISLATION

Homestead Act

On May 20, 1862, President Lincoln signed the Homestead Act. This law, still in force, permitted any single person over 20 years of age to select 160 acres of land in the public domain and acquire title to it after residing on the land for a period of 5 years and completing certain requirements as to cultivation. The period of residence was later reduced to 14 months, and entry by anyone already owning 160 acres of other lands was prohibited. The act contained no water-development requirements or restrictions.

Desert Land Act

The Desert Land Act was enacted March 3, 1877, in recognition of the limited application of the Homestead Act. As first approved, it provided that title to 640 acres of arid land could be procured by conducting water to the land and reclaiming 20 percent of it. In 1890, the acreage was reduced to 320 acres. In order to receive a patent, at least 40 acres had to be irrigated. From 1877 to 1967, a total of 375,057 acres had been patented under the Desert Land Act in Nevada.¹

¹ U.S. Bureau of Land Management, 1968, Public land statistics, 1967: U.S. Department of Interior, Bureau of Land Management, p. 52.

APPENDIX 4

STATE ENGINEERS SINCE CREATION OF OFFICE, 1903

<u>State Engineer</u>	<u>Period of Tenure</u>
1. A.E. Chandler	May 29, 1903 - Apr. 30, 1905
2. Henry Thurtell	May 1, 1905 - Apr. 30, 1907
3. Frank R. Nicholas	May 1, 1907 - Mar. 3, 1910
4. Emmet D. Boyle	Mar. 8, 1910 - Mar. 20, 1911
5. William M. Kearney	Mar. 21, 1911 - May 15, 1917
6. James G. Scrugham	May 16, 1917 - Jan. 10, 1918
7. Seymour Case	Jan. 25, 1918 - Mar. 27, 1919
8. James G. Scrugham	Mar. 28, 1919 - Oct. 6, 1922
9. Robert A. Allen	Oct. 7, 1922 - Mar. 28, 1927
10. George W. Malone	Mar. 29, 1927 - May 28, 1935
11. Alfred Merritt Smith	May 29, 1935 - June 5, 1951
12. Hugh A. Shamberger	June 6, 1951 - June 30, 1957
13. Edmund A. Muth	July 1, 1957 - July 3, 1962
14. Elmo J. DeRicco	July 5, 1962 - Dec. 31, 1964
15. George W. Hennen	Jan. 1, 1965 - June 30, 1967
16. Roland D. Westergard	July 1, 1967 - Dec. 31, 1978
17. William J. Newman	Jan. 1, 1979 - July 3, 1981
18. Peter G. Morros	July 6, 1981 - Feb. 7, 1990
19. R. Michael Turnipseed	Feb. 20, 1990

DIRECTORS, NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES, SINCE CREATION OF OFFICE, 1957

<u>Director</u>	<u>Period of Tenure</u>
1. Hugh A. Shamberger	July 1, 1957 - Jan. 1, 1965
2. Elmo J. DeRicco	Jan. 1, 1965 - Jan. 1, 1977
3. Norman S. Hall	Jan. 1, 1977 - Jan. 1, 1979
4. Roland D. Westergard	Jan. 1, 1979 - Feb. 7, 1990
5. Peter G. Morros	Feb. 8, 1990

U.S. GEOLOGICAL SURVEY PERSONNEL IN CHARGE OF HYDROLOGIC COOPERATIVE PROGRAMS IN NEVADA

The U.S. Geological Survey began the measurement of Nevada streams in 1889. As funds were limited, the work was carried on in a piece-meal manner until 1901 when the Nevada State Legislature appropriated \$2,000 for stream measurement. Until the appointment of the State Engineer in 1903, the work was under the direction of L.H. Taylor, who in 1903 became the supervisory engineer for the U.S. Reclamation Service.

Following the creation of the Office of State Engineer in 1903, an agreement was reached between F.H. Newell, Chief Engineer of the U.S. Reclamation Service, and State Engineer A.E. Chandler, whereby the State Engineer acted, without salary, as resident hydrographer of the U.S. Geological Survey. Under this agreement, all the U.S. Geological Survey stream stations were placed under the control of the State Engineer. The State paid his subsistence expenses and the Survey paid the hotel bills.

From 1903 to July 1, 1908, regular stream-gaging stations were maintained. When the State failed to appropriate matching money from July 1908 to July 1913, no cooperative program between the two agencies was carried on. However, starting in 1913, the stream-gaging program has been developed to a great extent and has proven worthwhile. The cooperative ground-water program began in 1945 and continued until the consolidation of the Surface Water and Ground Water Branches in 1962. Since then the cooperative program has been under the direction of the Nevada District Chief, Water Resources Division. The following is a listing of the U.S. Geological Survey officials who were in charge of the cooperative water resources program in Nevada.

SURFACE WATER BRANCH PERSONNEL, 1913-62

District Office	District Engineer	Period	Engineer in charge	Remarks
Salt Lake City, Utah for Utah and Nevada	E.A. Porter	1913-16		
	C.C. Jacob	1916-17		
	A.B. Purton	1917-42		
	M.J. Wilson	1942-47		During 1947, a Surface Water Branch suboffice was established in Carson City under the District Office that handled mainly personnel and financial matters.
	M.J. Wilson	1947-51	L.R. Sawyer	
		1951-59	C.H. Carstens	
		1960-61	L.J. Snell	
Carson City, Nev.	E.E. Harris	1961-62		On July 1, 1962, consolidation of the Surface Water and Ground Water Branches was made in Nevada. A District Office was established in Carson City with all Water Resources Division programs under the general supervision of the District Chief.

GROUND WATER BRANCH DISTRICT OFFICE, 1945-62

District Office	District Engineer	Period	Remarks
Carson City, Nev.	T.W. Robinson	1945-50	A cooperative ground-water study involving Las Vegas and Pahrump Valleys was started July 1, 1944, with G.B. Maxey, Associate Geologist in charge under general supervision of P.E. Dennis, District Geologist, Salt Lake City, Utah. On July 1, 1945, a statewide Ground Water District Office was established in Carson City.
	Omar Loeltz	1950-62	

WATER RESOURCES DIVISION DISTRICT OFFICE, 1962-present (1990)

District Office	District Chief	Period	Office Chief	Remarks
Carson City, Nev.	G.F. Worts, Jr.	1962-74		
	J.P. Monis	1974-77		
	F.T. Hidaka	1977-79		
	T.J. Durbin	1979-81		
	Terry Katzer	1981-82		Idaho and Nevada District Offices merged into one District in August 1982, with District Chief in Boise, Idaho, and Nevada Office Chief in Carson City.
Boise, Idaho	E.F. Hubbard, Jr.	1982-85	Terry Katzer	
		1985-86	Otto Moosburner	Acting Nevada Office Chief
		1986-87	W.J. Carswell, Jr.	
Carson City, Nev.	W.J. Carswell, Jr.	1987		Idaho-Nevada District demerged into separate districts in October 1987, with Nevada District Chief in Carson City.

APPENDIX 5

SPECIAL ARTICLES OF INTEREST THAT APPEAR IN THE STATE ENGINEERS' BIENNIAL REPORTS

Since the creation of the Office of State Engineer in 1903, the State Engineer, by law, was required to submit a report to the Governor every 2 years as to the affairs of his office during such period. This was faithfully carried out by the State Engineers until the creation of the Department of Conservation and Natural Resources in 1957. The 1957-58 Biennial Report was the final one which dealt only with the Office of State Engineer.

The Department of Conservation and Natural Resources, as originally established, included the Division of Water Resources, headed by the State Engineer; Division of Forestry under the guidance of the state forester; Division of State Lands in which the director of the Department was ex officio state land register of the Division of Oil and Gas Conservation Commission.

The Department has grown rapidly. In 1963, the Division of State Parks was added and subsequently the Divisions of Mineral Resources, Conservation District, Environmental Protection, Water Planning, Historic Preservation, and Archaeology. The law provides that the director of the Department may establish other divisions, as found necessary.

During the years the State Engineers' biennial reports were compiled (1909-58) and printed, special articles pertaining to the land and water resources of Nevada were included, most often by guest authors who were experts in their particular field. It is appropriate to briefly mention some of the most important ones as so few copies of the reports are now extant. About the only source where complete sets of these reports may be found are the libraries, although most of the reports may be found in the Office of State Engineer.

The following compilation gives the subject discussed, the biennial report (B.R.) and years, the page number, and a summary of the subject matter:

Civilian Defense

B.R. 1940-42, pp. 32-38.

Civilian defense during the Second World War is included in this report as the Office of State Engineer became the headquarters for all civilian-defense activities. Deputy and Assistant State Engineer Hugh Shamberger was appointed State director by Governor E.P. Carville. State Engineer Alfred Merritt Smith gave the director full authorization to carry on the civilian-defense work along with his duties as Assistant State Engineer. Full cooperation was given by other state agencies, especially the State Highway Department under Robert A. Allen. The work of the director and the many local civilian defense councils is documented in five volumes deposited in the State Library.

Colorado River Development Commission

B.R. 1929-30, pp. 89-96

B.R. 1931-32, pp. 56-69

B.R. 1932-34, pp. 65-78

B.R. 1934-36, pp. 94-107

These reports detail the large amount of work performed by this commission in safeguarding Nevada's interest, especially as to electric-power rates from Hoover Dam. The commission consisted of the Governor, State Engineer, and a member appointed by the Governor.

Colorado River Study

B.R. 1952-54, pp. 35-36.

Some of the early events leading up to the lengthy trial before a Master appointed by the U.S. Supreme Court involved the allocation of Colorado River water among Arizona, California, Nevada, New Mexico, and Utah. A more detailed account of the proceedings is set forth in the Report of the Department of Conservation and Natural Resource for the years 1957-59.

Conserving Nevada's Water Resources

B.R. 1948-50, pp. 29-46

A section of the biennial report contains a resumé of Nevada's water resources which was taken from a textbook prepared for Nevada schools in 1949 written by Assistant State Engineer Hugh A. Shamberger. The section covers the water cycle, distribution of water, the watersheds, the rivers of Nevada, major dams and reservoirs, snow surveys, ground water, the cooperative ground-water study, water law, and other references pertaining to the water resources of Nevada.

Humboldt River--Distribution of Water and Litigation

B.R. 1936-38, pp. 83-101

A description of the many legal and condemnation suits involved in the determination of water rights on the Humboldt River.

Humboldt River--Humboldt River Board

B.R. 1944-46, pp. 79-94

The organization of a Humboldt River Board, August 22, 1945, to act as an advisory group to the State Engineer in safeguarding the interests of the water users of the Humboldt River. At the organizational meeting, talks were given by a member of Federal and State representatives in the field of land and water.

Humboldt River--Quality of Water

B.R. 1940-42, pp. 108-114

B.R. 1942-44, pp. 46-58

A study of the salinity conditions of the Humboldt River water was prepared by M.R. Miller, Chemist, Nevada Agricultural Experiment Station, Laboratory of Research, University of Nevada, July 11 to December 31, 1941, and July 1, 1942, to December 31, 1943.

Humboldt River--The Humboldt Project (Rye Patch Dam)

B.R. 1934-36, pp. 75-79

L.J. Foster, Construction Engineer, U.S. Bureau of Reclamation, describes this project and the construction of the Rye Patch Dam on the Humboldt River, 23 miles northeast of Lovelock. Construction started in early 1934.

Lake Tahoe Basin--Water Use, 1948

B.R. 1948-50, pp. 87-113

A rather detailed survey was made of water use from Lake Tahoe during 1948 by all water users in California and Nevada; the report also gives an estimated population within the watershed in 1948. The maximum number of users for July and August was estimated to be 27,500 people, and the monthly average for the year was 9,000; this includes tourists and summer dwellers. The net consumptive use of water within the Lake Tahoe watershed for 1948 was estimated to be 5,190 acre-feet.

Las Vegas Valley--Artesian Basin

B.R. 1938-40, pp. 85-96

This is a report of the Las Vegas Valley artesian basin prior to the cooperative basin-wide underground-water study and subsequent to the leaky-well study by the U.S. Geological Survey in cooperation with the Office of State Engineer. A summary of the results of the leakage study is given, the study being financed by Clark County, City of Las Vegas, and Las Vegas Land and Water Company. The 1939 Nevada underground-water law is discussed and a listing of 340 wells is given.

Little Humboldt River--Channel Improvement Work

B.R. 1936-38, pp. 115-122

This article describes the work of the U.S. Civilian Conservation Corps, under the supervision of the U.S. Forest Service, in the installation of diversion structure and channel cleaning along the Little Humboldt River in Paradise Valley, Humboldt County.

Little Humboldt River--Storage Projects

B.R. 1921-22, pp. 66-68

Proposed sites are described for storage projects on the North Fork, Little Humboldt River, and on Martin Creek, one of the main tributaries to Little Humboldt River.

Muddy River Report

B.R. 1938-40, pp. 49-72

A detailed report describes the Muddy River Valley Irrigation Company, Moapa Indian Reservation, water rights, water supply, flood data, flood-control projects, the White Narrows dam site, storage of flood waters, flood control, storage of decreed water rights, and recommendations. The report was compiled by Deputy State Engineer Hugh Shamberger.

Newlands Reclamation Project, Carson River

B.R. 1929-30, pp. 141-147

This report, by D.S. Stuver, Project Manager, gives the history of the Newlands Project which started during 1903. Salient features of the project are set forth as well as a discussion of the water supply, project costs, and electric-power development.

Owyhee River

B.R. 1921-22, pp. 58-66

By an act of the Nevada State Legislature, a commission to be known as the Owyhee River Development Commission of Nevada was formed. Under the provisions of the act a reconnaissance study was made with a view to determine: (1) the practicability of diverting water from the South Fork of the Owyhee River to the Little Humboldt River, and (2) the feasibility of utilizing the Owyhee River water for the irrigation of lands on what is known as the Owyhee Desert. Apparently the studies advanced little beyond the 1922 and 1923 investigations.

Panaca, Lincoln County, Nevada--Ground-Water Possibilities

B.R. 1940-42, pp. 73-79

This report was written by Harry E. Wheeler, Associate Professor of Geology, University of Nevada, Reno. It covers the geology of the area, the Panaca Lake Beds, ground-water and artesian-water possibilities.

Public Domain, Brief History

B.R. 1936-38, pp. 109-112

This history was prepared by Cruz Venstrom, Land Use Planning Specialist, Nevada, U.S. Department of Agriculture, Bureau of Agricultural Economics, outlining the legal attempts of Nevada to control the public domain.

Quinn River Investigation

B.R. 1946-48, pp. 51-59

This report concerns the distribution of water rights on Quinn River in Humboldt County where the water rights were decreed under a civil suit. An act of the Nevada State Legislature in 1947 (Chapter 159, Statute 1947) provided that in such cases the District Court could order the State Engineer to make a hydrographic study and report, setting forth his recommendations as to the administration of water rights. On March 6, 1948, Alfred Merritt Smith, State Engineer, issued his report on the waters of Quinn River. This recommendation was approved by the District Court, following which a water commissioner was engaged to distribute such waters.

Resume of Distribution of Water Activities

B.R. 1929-30, pp. 45-56

This is an article on the early history of the Humboldt River and some of the problems of the State Engineer and supervising Water Commission had in litigation and river regulation.

Salmon River

B.R. 1948-50, pp. 70-80

As the result of a large number of applications being filed to appropriate water on tributaries of the Salmon River, a detailed study was made of this stream system. The resulting report of this study outlining a hydrographic program was included together with a map of the stream system.

Snow Surveys

B.R. 1919-20, pp. 22

B.R. 1925-26, pp. 14-18

B.R. 1927-28, pp. 61-65

B.R. 1942-44, pp. 30-35

The system of cooperative snow surveys was organized in 1919 by informal agreement between the States of California and Nevada. Dr. J.E. Church, Jr., of the University of Nevada is credited with being the originator of snow surveys, which through the years have spread throughout the world. The work in Nevada has been reported in the biennial reports starting with the 1919-20 report.

The 1925-26 Biennial Report contains a brief history of this work as outlined by Dr. Church. Professor H.P. Boardman, Civil Engineering Department of the University of Nevada, Reno, was a close associate of Dr. Church and became chairman of the Forecast Committee.

A good article on snow surveys is contained in the 1942-44 Biennial Report.

Stream-Runoff Measurements

B.R. 1936-38, pp. 154-161

A complete record of runoff measurements of major Nevada streams from 1895-1938, inclusive, is contained in this biennial report.

Supreme Court Decisions Relating to the Office of the State Engineer

B.R. 1934-36, pp. 108-115

A brief summary is presented of decisions of the Nevada Supreme Court relating to water and covering the period 1869-1936.

Town Water Supplies in Nevada

B.R. 1944-46 pp. 28-48

This article gives the name of the town, name of water company, and type of ownership in some 57 Nevada towns as of 1946. A description of the source of water supply for each town is set forth.

Truckee River Storage Project

B.R. 1936-38, pp. 113-115

A brief report on the Truckee River Storage Project was prepared by F.M. Spencer, Associate Engineer, U.S. Bureau of Reclamation, and sets forth the early studies for a dam and storage reservoir on the Little Truckee River. The details of Boca Dam, on which construction started during 1937, are set forth.

Truckee River, Upstream Storage

B.R. 1929-30, pp. 129-134

Studies were made by the U.S. Bureau of Reclamation in 1927-28 in investigating reservoir sites on the Truckee River and its tributaries.

Virgin River--Quality of Water, Lower Virgin River

B.R. 1944-46, pp. 95-99

A quality-of-water study on the Lower Virgin River was prepared by George Hardman, State Conservationist, U.S. Soil Conservation Service. The study covers the reach of the Virgin River from Littlefield, Ariz., to Riverside, Nev., from which the irrigation is water diverted for the Bunkerville, Ariz., and Mesquite, Nev., areas.

APPENDIX 6

WATER-SUPPLY PROBLEMS FACED BY EARLY MINING CAMPS OF NEVADA

The author, having served in the Office of State Engineer for more than 30 years, became well acquainted with every part of the State. Water-applications investigations took him into remote areas and in his travels he visited practically all the famous mining camps, especially the more productive ones. During the period 1933-65, the mining industry was at a low ebb. Few reduction mills were operating, and consequently few problems were associated with development of a water supply for the mining camps, mills, and mines. It was, therefore, not necessary for the author, or for that matter, any of the engineers from the Office of State Engineer, to become concerned with water problems confronted by the early mining camps or by the few newly developed mines.

During the 1930's and 1940's, many of the old mining camps that flourished during the 1860's and 1870's still retained their identities. The old dilapidated buildings were still standing and the old townsites were overgrown with sagebrush or other desert vegetation. This was also true of mining camps that flourished during the first two decades of this century.

The history of most of the early mining camps usually followed the same pattern. After the discovery would come the rush of prospectors to the new area, and if the region looked good, a camp would be set up with its saloons, gambling halls, and merchandise stores. Prospectors would swarm over the nearby hills, and the camp would fill up with mining promoters and the usual riff-raff always in attendance.

Seldom in the history of mining camps in Nevada was a source of water readily available. In the early stages of development, water would be hauled by wagon to supply the camp and mining work. If the ore bodies proved substantial, a reduction mill would be projected. Then the problem of a water supply of sufficient quantity to operate the mill would have to be solved. Either the ore would have to be conveyed to the water source or the water would have to be pumped to a mill site near the mine.

In the event that only one mill was contemplated, the mining company would find it advantageous to haul or tram the ore to the water source, which would usually be downhill from the mine. If the camp could support more than one mill, usually with a lively town, quite often a private water company would be formed and the water pumped to the places of use. The procedure varied from camp to camp.

The life of most mining camps in Nevada was of short duration--often only a few years. Unless the mining town happened to be a county seat, such as Pioche, Eureka, Austin, Tonopah, Virginia City, and Goldfield, when the ore supply was exhausted and mills closed down, the population, stores, saloons, gambling houses, and businesses made the great exodus. In most cases old buildings and mining structures would be abandoned, and sagebrush and other desert vegetation would take over. In a few cases, the buildings would be moved to another boomtown.

When the author first passed some of these old towns during the 1930's and 1940's, many of the old buildings were still to be seen, and the towns looked just as they were--deserted ghost towns.

However, during the 1950's and after, old buildings were torn down by vandals and burned or the lumber stolen to be used elsewhere. When the author visited some of the old townsites during the 1960's and 1970's, little remained to indicate that at one time flourishing mining camps existed, except where county seats were created in an established mining camp and in a few other old camps, such as Silver Peak.

Fortunately, most of the early mining towns had one or more newspapers and usually a photographer. So most of the interesting history of the mining camps of Nevada has been preserved in print and photographs.

The Historical Mining-Camps Series

The author, after spending nearly 34 years in the service of State of Nevada, mostly all in the field of water and related resources, retired January 1, 1965. As do so many professionals who retire, the author desired to spend a part of his time in work that would be both interesting and productive. He often wondered how old-time productive mines solved their water-supply problems.

One day when this author was visiting George F. Worts, Jr., Nevada District Chief, U.S. Geological Survey, and his assistant Thomas E. Eakin, a discussion involved the water supplies of the old Nevada mining camps. In Nevada, as in some of the other arid western states, the ore deposits and a source of water supply were most often widely separated. It was either pipe the water to the mill-site or convey the ore to where a sufficient water supply was available. It was recognized that little attention had been given this particular subject of water supply by historians, with the exception of water supply in Virginia City.

Mr. Worts suggested the author might wish to try his hand on a part-time basis, as a research geologist. Being always interested in the history of the State, the author lost no time in getting started. It was only natural that his first effort was one on the water supply for the Comstock at Virginia City, where water was diverted from both the eastern and western slopes of the Sierra Nevada overlooking Lake Tahoe. The first water from the eastern slope of the Sierra Nevada reached Virginia City during 1873. It involved over 13 miles of wooden flume and a 7-mile inverted siphon. The siphon was 12 inches in diameter and had a pressure head of more than 819 pounds per square inch at the low point at Lakeview saddle. The construction of this pipeline was considered one of the great engineering feats of the 19th century. Two other pipelines were constructed along the same route, the second in 1875 and the third in 1887. Only the second pipeline is now in use.

When the author started this project, he did not realize the tremendous amount of research and travel needed to develop the full history of a mining camp. He succeeded in completing 10 books, the last one being the history of Goldfield, completed in 1982. The books cover the following camps:

- | | |
|--|---|
| 1. The Story of the Water Supply for the Comstock. | Printed by the U.S. Government Printing Office, as U.S. Geological Survey Professional Paper 779. |
| 2. Rawhide, 1970. | Nevada State Printing Office. |
| 3. Seven Troughs, 1972. | Caxton Printers, Caldwell, Idaho. |
| 4. Rochester, 1973. | Western Printing & Publishing Co., Sparks, Nevada. |
| 5. Fairview, 1973. | " |
| 6. Wonder, 1974. | " |
| 7. Weepah, 1975. | " |
| 8. Silver Peak, 1976. | " |
| 9. Candelaria and its Neighbors, 1978. | " |
| 10. Goldfield, 1982. | " |

The author touched on only a few of the mining camps which required great engineering skill to pipe the water to the mills. Needless to say, this project could not have been completed without the full cooperation and encouragement of the Nevada District Chiefs, Water Resources Division, U.S. Geological Survey, Carson City, Nevada. First, there was George F. (Skip) Worts, Jr., followed by John P. Monis, Frank Hidaka, Timothy J. Durbin, and Terry Katzner. Other State and Federal Agencies and many individuals also furnished assistance.